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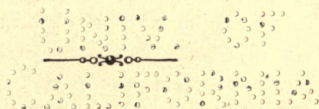
ELEMENTS OF CONSTRUCTION

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KING'S SERIES IN WOODWORK AND CARPENTRY

ELEMENTS OF WOODWORK

ELEMENTS OF CONSTRUCTION

CONSTRUCTIVE CARPENTRY

INSIDE FINISHING

HANDBOOK FOR TEACHERS

OCT 7 1911

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PREFACE TO THE SERIES

THIS series consists of five volumes, four of which are intended as textbooks for pupils in manual-training, industrial, trade, technical, or normal schools. The fifth book of the series, the "Handbook in Woodwork and Carpentry," is for the use of teachers and of normal students who expect to teach the subjects treated in the other four volumes.

Of the pupils' volumes, the first two, "Elements of Woodwork" and "Elements of Construction," are adapted to the needs of students in manual-training schools, or in any institution in which elementary woodwork is taught, whether as purely educational handwork, or as preparatory to a high, or trade, school course in carpentry or vocational training.

The volumes "Constructive Carpentry" and "Inside Finishing" are planned with special reference to the students of technical, industrial, or trade schools, who have passed through the work of the first two volumes, or their equivalent. The subjects treated are those which will be of greatest value to both the prospective and the finished workman.

For the many teachers who are obliged to follow a required course, but who are allowed to introduce supplementary or optional models under certain conditions, and for others who have more liberty and are able to make such changes as they see fit, this series will be found perfectly adaptable, regardless of the grades taught. To accomplish this, the material has been arranged by topics, which may be used by the teacher irrespective of the sequence, as each topic has to the greatest extent possible been treated independently.

The author is indebted to Dr. George A. Hubbell, Ph.D., now President of the Lincoln Memorial University, for encouragement and advice in preparing for and planning the series, and to George R. Swain, Principal of the Eastern High School of Bay City, Michigan, for valuable aid in revising the manuscript.

Acknowledgment is due various educational and trade periodicals, and the publications of the United States Departments of Education and of Forestry, for the helpful suggestions that the author has gleaned from their pages.

The illustrations in this Series, with the exception of the photographs in "Elements of Woodwork" and "Elements of Construction," are from drawings made by the author.

CHARLES A. KING.

BAY CITY, MICHIGAN.

PREFACE TO ELEMENTS OF CONSTRUCTION

THIS volume deals with the use of the common woodworking tools, the simple forms of construction used in fastening wood together, and the reading and understanding of simple drawings—all of which will be found of indispensable value, not only to the student of manual training, but to those who, either as amateurs or professionals, have anything to do with work of a mechanical nature.

The problems in elementary construction are intended to familiarize the pupil with their various uses, and one or more of these problems, bearing upon the work he is to do, should precede the undertaking of any really important work.

Students should be encouraged to create new models or exercises for themselves, following those shown only as a guide to the degree of difficulty or for suggestions as to methods of construction.

The arithmetic problems in this volume are intended to be used in connection with the class work, the teacher adapting them to his uses as may seem best. They are of the same nature as those with which the workman will come in daily contact, and should be used as the basis for mental drill as much as possible and for the teaching of the short cuts which the man in business should acquire.

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CHAPTER I

TOOLS

1. **How to purchase tools.** — (A.) The quality of the tools used by the mechanic is of the greatest importance. They should be selected carefully, and while it is the poorest economy to buy any but the best, the best are not necessarily the most finely finished.

(B.) In purchasing tools, it is well to remember that those made especially for some dealer, and bearing his name, if sold for a less price than the best, are usually not of the highest grade, and should be shunned. It is wisest to buy standard makes, examining them carefully to be sure that there are no visible defects. The temper of steel may be discovered only by use, and any defect in the best grades of tools is made good upon complaint to the dealer.

2. **Benches.** — (A.) Figure 1 shows the type of bench used in the most up-to-date carpenter and cabinet shops, while that used by carpenters for ordinary work usually is of the type shown in Fig. 2.

(B.) In many manual-training schools, the benches are of the former type, and, in the most completely equipped schools, are fitted with locked drawers and closets for the reception of tools, not only to keep the latter in condition for use, but to insure that the outfit is complete, and to make it possible to place the responsibility for damage or loss.

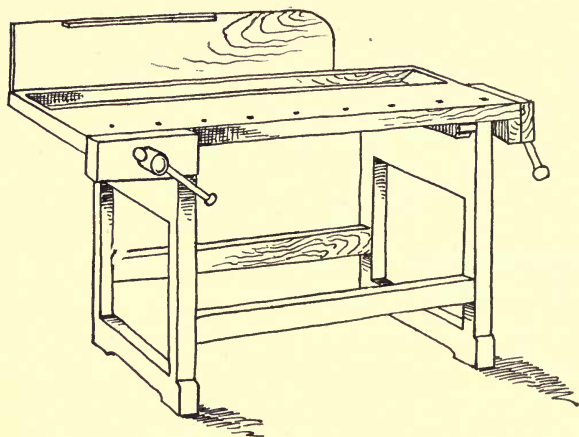


FIG. 1.—MANUAL-TRAINING BENCH.

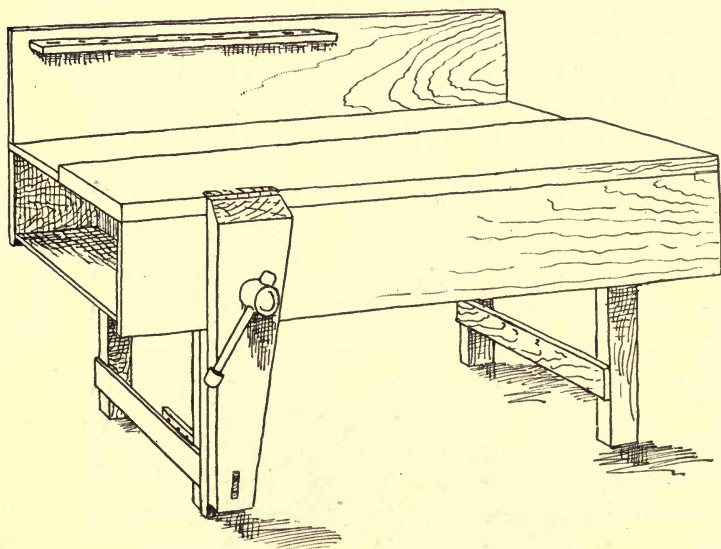


FIG. 2.—CARPENTER'S BENCH.

(C.) The *vises* should be of the modern, quick action design, which, on account of the rapidity with which they work, are superseding the old-fashioned wooden and iron screw vises.

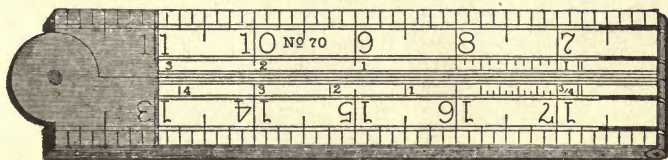


FIG. 3.—TWO-FOOT, FOUR-FOLD RULE.

3. **Rules.** — The two-foot, four-fold *rule* (Fig. 3) is the one generally used by carpenters. It is made of different grades, the more expensive makes being divided into 16ths, 8ths, 10ths, and 12ths, and having the $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1", $1\frac{1}{2}$ ", and 3" scales upon them. Although the cheaper rule is just as accurate, it is divided usually into 8ths and 16ths only. The form of rule shown in Fig. 4 is becoming quite popular, as it is longer. Since rules are easily lost or broken, many workmen have a good rule for scaling, and a cheaper one for general work.



FIG. 4.—ZIGZAG RULE.

4. **The try-square (A.)** consists of the beam (Fig. 5, *a*), which is generally of metal-lined wood, and the blade (*b*), which is a thin piece of steel.

(B.) Too much care cannot be exercised in the selection of this tool, as one which is not perfectly true may cause much trouble. To test a square, hold the beam

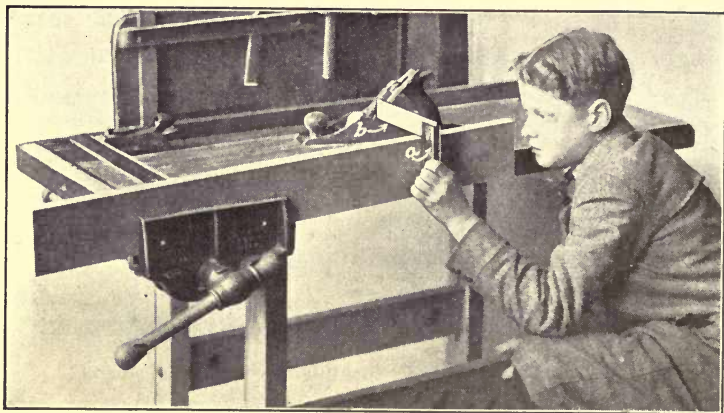


FIG. 5.—POSITION OF TRY-SQUARE IN SQUARING AN EDGE.
a, the beam ; *b*, the blade.

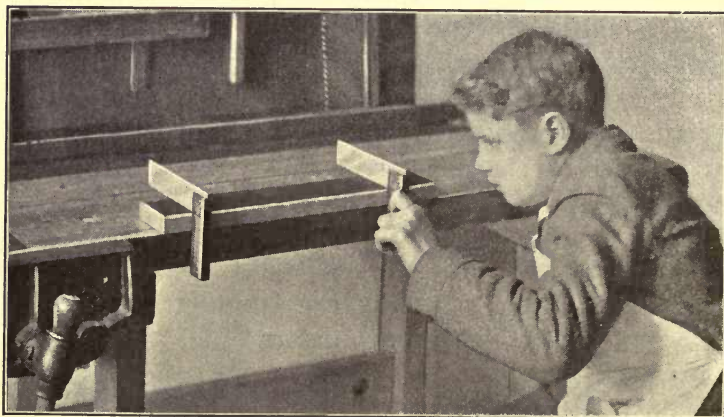


FIG. 6.—USE OF TWO TRY-SQUARES TO SEE IF PIECE OF WOOD IS "OUT OF WIND."

against a perfectly straight and square edge of a board which is wide enough to allow a knife line to be made the entire length of the blade. Then turn the square over,

the other side up, and, holding the beam against the same edge, move the blade to the line. If the jointed edge of the board and the square are perfectly accurate, the knife line and the edge of the board will perfectly coincide.

(C.) The use of this tool in squaring an edge is shown in Fig. 5. The piece being squared should be in such a position that the try-square will be between the eye and the light; in this way, the slightest inaccuracy may be detected. In Fig. 7 is shown the position of the try-square when used to make a line by the edge of the blade. If working from the edge indicated, hold

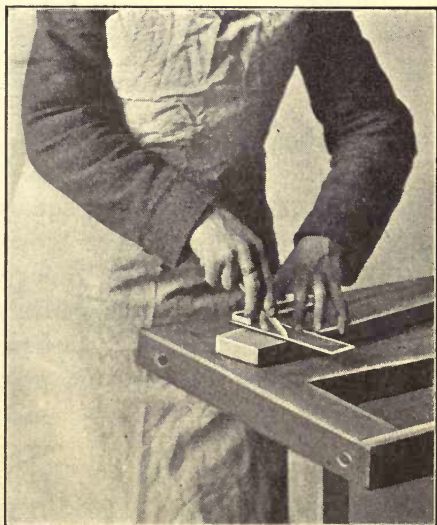


FIG. 7.—POSITION OF TRY-SQUARE WHEN MAKING A LINE.

the beam against the edge with the thumb, and at the same time hold the blade down with one or two fingers, using the others to steady the square in its place upon the board.

(D.) Two try-squares may be used to see if a piece of wood is “out of wind” (*i* sounded as in kind) by the method indicated in Fig. 6.

Two pieces of wood known as *winding sticks*, of exactly the same width and perfectly parallel, are often used in manual-training schools for this purpose; they

are rarely used in a shop, however, as a workman generally will use two steel squares if the piece is too

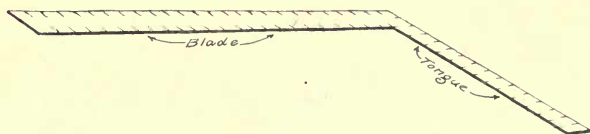


FIG. 8.—STEEL, OR FRAMING, SQUARE.

large to be sighted accurately without some aid of this sort.

5. The steel, or framing, square (Fig. 8) is often used as a try-square upon large work, though its most important use is in framing or roof construction. It is indispensable in finding the lengths and the angles of rafters,

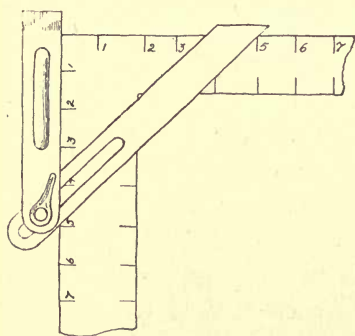


FIG. 9.—BEVEL AND STEEL SQUARE.

The bevel is set at an angle of 45° .

braces, etc. Its use for this purpose will be explained in "Constructive Carpentry." The long side of the framing square is known as the "blade," and the short side as the "tongue."

6. The bevel (Fig. 9) may be set for use in marking and testing any angle, in the same manner that the try-square is used upon rectangular work. The

illustration shows the bevel and the steel square in position for setting the bevel at an angle of 45° . It will be noticed that the blade of the bevel rests upon the same figures upon both the blade and the tongue of the square.

7. The gauge (A.), Fig. 10, is for the purpose of making lines parallel to the face or working side or edge. Usually it is made in four pieces: the "head" (*a*), which is held against the face side or edge; the "stick" (*bb*), upon which the head moves; the "thumbscrew" (*c*), which holds the head firmly in its position upon the stick; and the "point" (*d*), which makes the desired mark upon the wood.

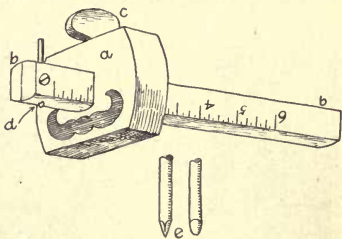


FIG. 10. — MARKING GAUGE.

a, the head; *bb*, the stick; *c*, the thumbscrew; *d*, the point.

(B.) A rule should be used in setting the gauge, unless one is certain that the point is located accurately with regard to the graduations upon the stick.

The point should be sharpened to work with either a push or pull cut, as at *e*.

(C.) The gauge should be grasped as shown in Fig. 11, and generally used with a push, though it is occasionally pulled toward the worker. One should always work from the face side of the piece.

If the point enters the wood too deeply, it may be set back, or the gauge carried on the corner of the stick as indicated, which will govern the depth of the cut. Do not use a dull gauge, or one with a round point like a pencil, as it will tear the wood, instead of making a clean cut or scratch.

8. The hammer (A.) is used by the average woodworker more than any other tool. The "face" (Fig. 12, *a*) and the "claws" (*b*) should be tempered carefully, as they will either bruise or bend if too soft, or

break if too hard. The eye (*c*) is made longer than it is wide, to prevent the head from turning on the handle, and larger at the outside of the head than it is at the neck,

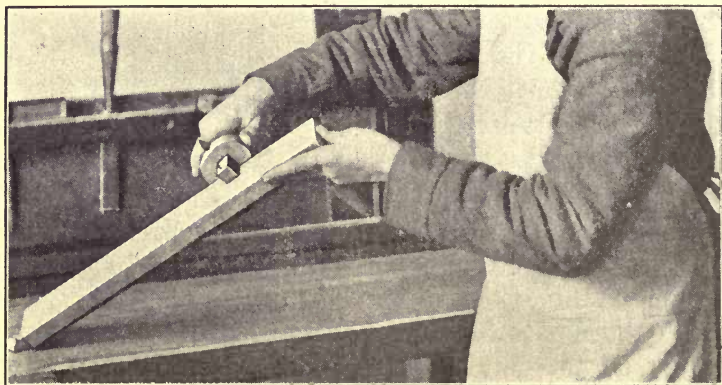


FIG. 11.—MARKING GAUGE IN USE.

so that the handle may be firmly wedged in the eye or socket. The neck (*d*), by extending upon the handle as it does, adds much to the strength of the connection.

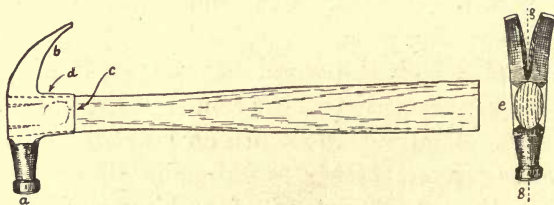


FIG. 12.—CLAW HAMMER.

a, the face; *b*, the claws; *c*, the eye; *d*, the neck; *e*, grain of neck.

The handle should be of young, tough, straight-grained hickory, elliptical in section, and of a size to be grasped easily.

The grain should be perfectly straight at the neck, and the annual layers should show lengthwise of the ellipse at the end, as at *e*. The handle should be fitted and wedged, or "hung" in such a way that a nail may be driven home in a flat surface without the knuckles striking, which means that the center of the handle should be about parallel with the flat surface. A line lengthwise of the head through the eye should exactly coincide with the long, or major, axis of the ellipse at the end of the handle, as at *gg*, or pounded fingers will result.

The *bell-faced* hammer is to be preferred to the *flat-faced* type, as it will not mar the wood so badly if the nail is missed, though more skill is required to use it. Upon rough work, the bell-faced hammer will sink the nail beneath the surface without bruising the wood badly. Upon inside work, the nails should be sunk beneath the surface with a nail set.

(B.) In nailing, the young workman should acquire the habit of grasping the handle of the hammer at the end, as this will give greater force to the blow. Upon light work, the hand will naturally slip a little toward the head. Nails should generally be driven in a slanting direction, as they hold better than if driven straight. When nails are driven as shown at *a*, Fig. 13, it is called "toenailing," and when driven sufficiently to hold, but not driven home, as at *b*, they are said to be "tacked." Nails are driven this way when they are to be pulled out again, as in stay laths, and in fastening pieces temporarily.

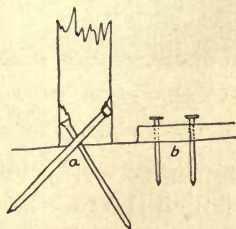


FIG. 13.

a, toenailing; *b*, tacking,

In forcing matched boards together, do not pound directly upon the tongue edge of the board, but upon a waste piece of the same material, as the tongue will be



FIG. 14. — BLIND NAILING AND USE OF A NAIL SET.

bruised so that the next board will not form a good joint. Care should be used that the hammer does not strike the edge of the board when the nail is driven home. To guard against this, a nail set should be used to sink the head beneath the surface, as in Fig. 14, so that the next board will come to its place without trouble. This is called "blind nailing."

9. The hatchet

(A.) is used for hewing light work, for shingling, and as a heavy hammer, though the face is rarely tempered to stand very heavy usage (Fig. 15, *a*).

(B.) A *hand ax*, or *broad hatchet* (Fig. 15, *b*), usually is a better grade of tool than the hatchet, and as it is of greater weight, is better adapted for heavy work. For general use it should be sharpened as at *c*; but for hewing to a line, an edge like *d* gives the best results.

10. The mallet. — This tool should be used upon chisel handles, as a hammer will destroy the handle in a very short time. Mallets are of two shapes, the *square-faced* (Fig. 16, *a*) and the *round* mallet (*b*), the latter being preferred by many workmen as it will always strike a fair blow upon the chisel handle, while the square-faced mallet sometimes will miss, and inflict a painful blow upon the hand. In general, the handle of a square-

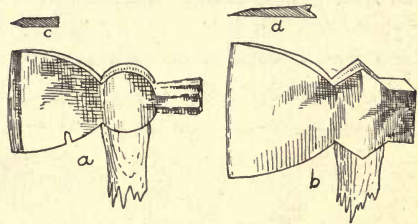


FIG. 15. — HATCHET AND HAND AX.

a, hatchet; *b*, hand ax; *c*, edge for general use; *d*, edge for hewing to a line.

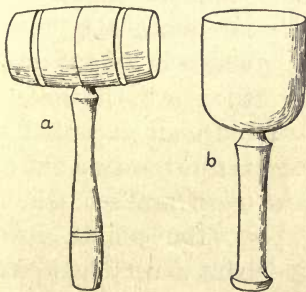


FIG. 16. — MALLETs.

a, square-faced mallet; *b*, round mallet.

faced mallet is round, which allows the mallet to turn in the hand; if the handle were made elliptical, like a hammer handle, there would be less likelihood of missing the chisel handle when striking a blow.

11. Saws. — (A.) The saws used by the carpenter are for cutting parallel with, or across, the grain, or a combination of the two, and all are composed of two parts, the “handle” and the “blade.”

The teeth of a *ripsaw* (Fig. 17, A) are suitable for sawing in a direction parallel with the general direction of the grain. The points of different saws may be from one third to one seventh of an inch apart, and form a series of chisels, the cutting edges of which are filed so that they

are at right angles to the sides of the blade. In action, the saw is pushed against the wood, each tooth cutting a little deeper than the one preceding it.

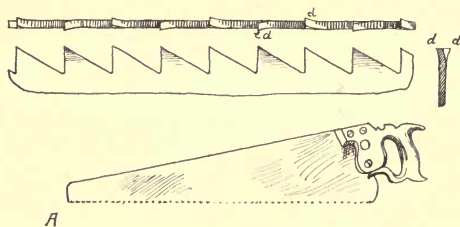


FIG. 17, A. RIPSAW.

dd, view and section of setting of teeth.

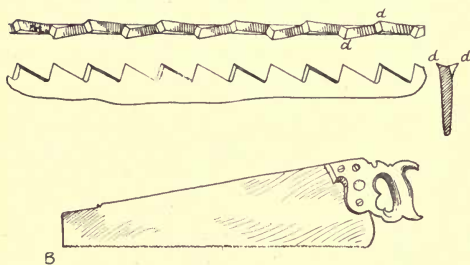


FIG. 17, B. CUTTING-OFF SAW.

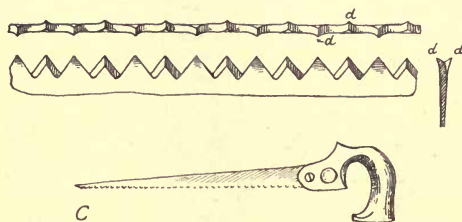


FIG. 17, C. COMPASS, OR KEYHOLE, SAW.

FIG. 17. — SAWS.

(In each of the three varieties of saw teeth shown above, the set of the teeth is exaggerated.)

The *cutting-off saw* (Fig. 17, *B*) has from six to twelve knife-pointed teeth to an inch, the cutting edges being parallel to the sides of the blade, and filed so that the point of the tooth is upon the side which is set beyond the side of the blade.

In all except the finest saws, the teeth are set; that is, the points are bent a very little in such a way as to make the cut wider than the thickness of the blade, so that the saw may cut through the wood without binding, which it could not

do if the cut were of the same thickness as the blade. The

blades of all high grade saws are thinner upon the back than upon the cutting edge, but if a saw is to be used upon the finest work, this difference in the thickness of the two edges of the blade is supposed to make the setting of the saw unnecessary. For general work, it will be found that a saw will be much more efficient if it is given a set adapted to the size of the teeth, or to the nature of the work it is expected to do.

The *compass*, or *keyhole*, saw (Fig. 17, C) is used where it is necessary that the saw should cut both with and across the grain. It is used to start the cut for a rip- or cutting-off saw, when a cut has to be made in the surface of a board. This saw is used also in many places where it is not practicable to use a larger saw, and for sawing curves. In order to allow it to cut around curves easily, the face, or cutting edge, is considerably thicker than the back, and the blade is made of soft metal. It may then be given a heavy set, so that it will bend instead of breaking or kinking, as it would be liable to do from the nature of its work if made of tempered steel.

Some carpenters, working upon job work, where it is desirable to carry as few tools as possible, have a narrow 20" or 22" saw sharpened like a compass saw, which for ordinary work is quite satisfactory as either a cutting-off or a rip-saw, thus making another saw unnecessary.

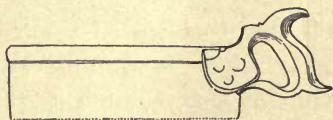


FIG. 18.—BACKSAW.

The *backsaw* (Fig. 18) is used upon fine work; it is filed like a cutting-off saw, but the teeth have rather more hook, and it often has as many as fifteen teeth to the inch, though a twelve-tooth saw is as fine as is generally

used. The thick back is to stiffen the blade of the saw, and if the latter becomes sprung, a light blow upon the back, as though to drive it upon the blade, will usually straighten it.

(B.) In buying a saw, select one which is thicker upon the cutting edge than upon the back; this allows the saw to be used upon very fine work with little or no setting. See that the handle fits the hand, and that the saw hangs to suit, or "feels right." This is a matter concerning the balance and the weight of the tool, which cannot be described, but which any one accustomed to using tools will miss when a tool not possessing this quality is placed in his hand.

A saw blade, unless very short and thick, should bend so that the point may be put through the handle, and, upon being released, should instantly resume its shape. It should also bend evenly in proportion to the width and the gauge of the saw, and should be as thin as the stiffness of the blade will permit, as a saw of this sort cuts less wood and therefore runs with less resistance. A compass saw, being softer, is not expected to stand the above test.

A 26" or a 28" blade is best for a heavy rip- or cutting-off saw to be used upon coarse work; but for fine work, a 22" blade, commonly known as a "panel saw," is a convenient size, though a 20" or a 24" blade is preferred by many workmen.

(C.) A hard saw is best for fine work. For general work, most workmen prefer a saw of medium hardness, as the teeth of a hard saw are apt to break in setting. Moreover the edge of a hard saw, if it comes in contact with metal, requires filing just about as quickly

as that of a soft saw, and is much more difficult to sharpen than the latter. If always filed by an expert filer, however, a hard saw is superior in every way to any other.

(D.) The handle of the saw should be grasped firmly by three fingers, as in Fig. 19, with the fore-finger extended along the side of the saw, thus

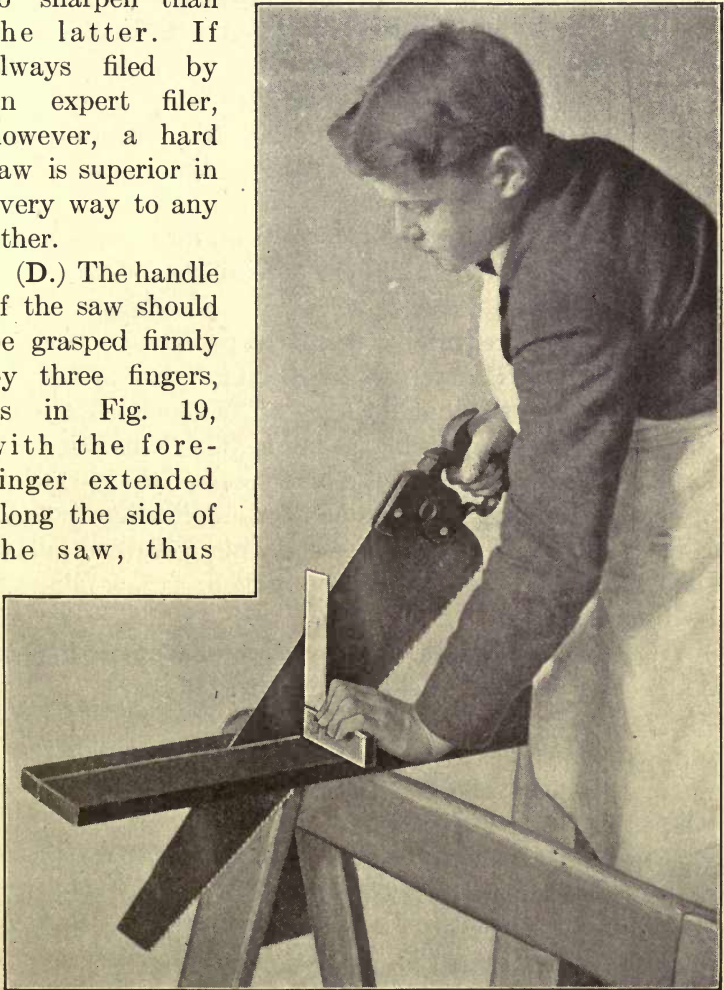


FIG. 19. — USE OF THE SAW.

Showing the method of using a try-square to insure accuracy.

making more room for the three fingers, and giving better control of the saw. Very little strength should be used in forcing a fine saw to cut, as its own weight generally is sufficient. If the saw is forced, it will not run smoothly, but will bind; and if a thin board is being worked, the saw is apt to split it. The saw should be used from the face side of the material, so that any splinters or variation will be upon the back side and out of sight.

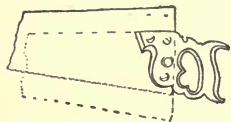


FIG. 20.—RESET SAW HANDLE.

(E.) It is the custom of some carpenters to reset the handles of their heavy saws by drilling holes through the blade, so that the handle may be fastened as close to the cutting edge as possible, as in Fig. 20. This brings the force of the stroke nearer the direct line of the cut, which obviously allows a more economical application of force. Never leave a saw in a cut, for if the piece of wood falls off the trestles, the saw is apt to be broken. (Saw-filing will be discussed later.)

12. The knife blade used by the woodworker for general work is similar to that shown in Fig. 21, at *A*. That shown at *B* is the form of blade in most common use in manual-training schools, as it is better adapted for whittling, and as its shape assists the student to some extent to prevent the knife from following the grain.

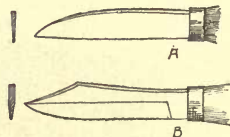


FIG. 21.—KNIFE BLADES.

A, blade used by woodworker for general work; *B*, blade used in manual-training schools.

13. Planes.—(A.) The *plane* is the most complex, as well as one of the most important, tools which the woodworker uses, and a high grade of

skill is necessary to keep it in order, as well as to use it properly.

(B.) The only plane in use until recent years had a wooden stock, and the iron was adjusted by blows with a hammer; this form of plane has changed very little since the first types were invented, as planes of ancient

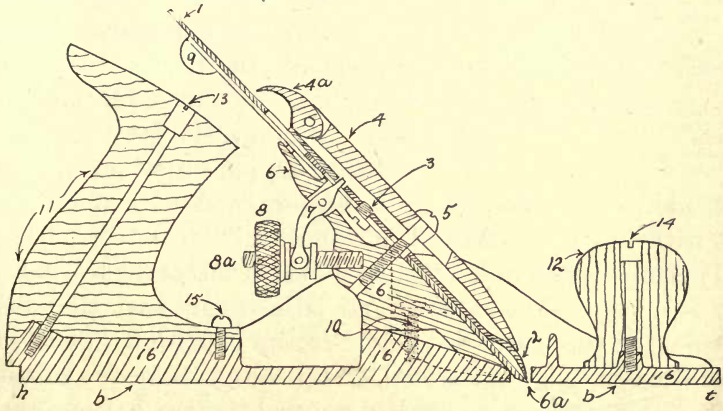


FIG. 22.—SECTION OF IRON PLANE.

1, cutter, iron, or bit; 2, cap iron; 3, plane iron screw; 4, cap lever; 4 a, cam; 5, cap screw; 6, frog; 6 a, mouth; 7, Y lever; 8, vertical adjusting nut; 8 a, vertical adjusting screw; 9, lateral adjustment; 10, frog screws; 11, handle; 12, knob; 13, handle bolt and nut; 14, bolt knob and nut; 15, handle screw; 16, bottom, or stock.

times have been found which in all essentials are practically the same as those in use to-day.

(C.) Our modern planes are more easily adjusted and more convenient to use, though they will do no better work than the wooden planes of our forefathers, which are still preferred by many of the best workmen. The face of an iron plane holds its shape permanently, while it is necessary that the wooden plane should be jointed occasionally.

(D.) There are planes for every conceivable purpose, all constructed upon the same general principle as the common bench plane which we shall discuss later. These planes are adjusted by screws and levers, which are very simple, and any one understanding them may easily comprehend the more intricate molding, or universal, planes.

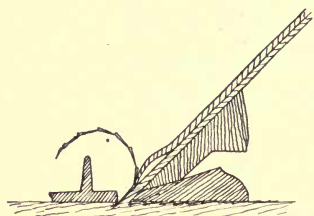


FIG. 23. — RESULT OF USING PLANE WITH IMPROPERLY ADJUSTED CAP IRON.

The adjustment of the modern plane may be understood by a careful study of Fig. 22 and by comparing it with the plane itself. The “cutter,” “iron,” or “bit” (1) and the “cap iron” (2) are the essentials of the tool, and it is upon their condition and adjustment that the efficiency of the plane depends. If the cap iron is set too far from the edge of the iron, and if the cut is made against the grain, the shaving will not break before it leads the iron into the wood, as shown in Fig. 23. If the cap iron is set somewhat less than $\frac{1}{16}$ " from the edge of the cutter, according to the wood being planed, it will break the shaving nearly as soon as it is cut, as in Fig. 24, and will result in a smooth, clean surface. The closer the cap iron is set to the edge, the smoother the iron will cut, as the breaks in the shaving are thereby made shorter.

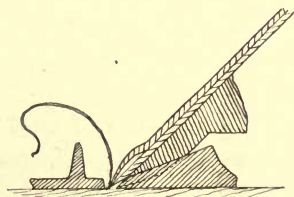


FIG. 24. — RESULT OF, USING PLANE WITH CAP IRON ADJUSTED PROPERLY.

It will be seen also that the closer the bottom of the cap

iron (2) is set to the edge of the cutter (1), the shorter the breaks will be, as in Fig. 24, and the more smoothly the plane will cut. The plane "iron screw" (3) holds the edge of the cutter (1) and the bottom of the cap iron (2) in their desired relation. The "cap lever" (4), being pressed against the under side of the head of the "cap screw" (5) by the "cam" (4 *a*), holds the iron in its place, and presses the cap iron (2) firmly against the top of the cutter (1). Unless the cap iron fits the face of the cutter perfectly, the plane will not work satisfactorily. The "frog" (6) carries all the adjusting mechanism of the plane, and may be moved backward or forward to reduce or enlarge the "mouth" (6 *a*), which should be no larger than is necessary to allow the shavings to pass freely. The frog rarely will require readjusting after it has been properly located.

The "Y lever" (7) forces the plane irons (1 and 2) in or out simultaneously, which governs the projection, or "set," of the edge of the cutter (1) beyond the face, or "sole" (*b*), of the "plane stock," and thus the thickness of the shaving which the plane will cut. The "adjusting nut" (8) moves freely upon the "screw" (8 *a*) and operates the Y lever (7). The "lateral adjustment" (9) is for the purpose of forcing the iron to cut in the exact center of the width of the face (*b*) of the plane. The two "frog screws" (10) hold the frog rigidly in the position which will make the throat (6 *a*) of the desired size.

The above illustrates all the adjusting mechanism; the other parts of the plane are as follows: "handle" (11); "knob" (12); "handle bolt" and "nut" (13); "knob bolt" and "nut" (14); "handle screw" (15); "bottom," or "stock" (16).

The face, or sole, of the plane (b) must be perfectly straight, or good work cannot be done. The ends of the



FIG. 25. — SETTING A PLANE.

plane (h and t) are called the "heel" and "toe," respectively. The "mouth" of the plane (between 6 a and 2) must be kept clear of shavings, or it may become clogged.

(E.) In setting a plane, do not pass the fingers over the face, or sole, as cut fingers may result. Hold the plane as shown in Fig. 25, and look toward the light, when the exact

projection of the cutter may be seen. Notice the position of the fingers of the left hand, and that the eye glances from toe to heel. This leaves the right hand free to make the adjustments. This is a workmanlike way of setting a plane, and in this, as in all handling of tools, awkwardness should be avoided.

14. Sharpening a plane. — (A.) An important part of this process is *the grinding of the cutter*. Set the cap back about $\frac{1}{8}$ " from the edge of the iron, and use it as a guide by which to grind the iron perfectly square, as at A, Fig. 26. The cap iron should be kept perfectly square, and never touched except to fit it to the cutter, or, if it is

too thick to allow the shavings to pass freely, to file the top of it to the proper thickness. If the tool is kept in order skillfully, the cap will need care only upon rare occasions.

The cutter should be held firmly to the grindstone or emery wheel and kept moving from side to side to prevent wearing the stone in one place. The grinding should all be done upon the beveled side of the cutter, which should be held upon the stone

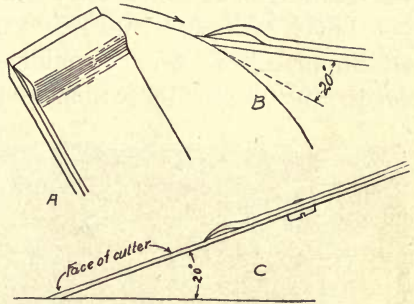


FIG. 26.—WHETTING AND GRINDING OF PLANE.

A, cap set as guide for grinding iron perfectly square; B, cutter held at an angle of 20°; C, cap iron carried back until the screw stops at the top of the slot of the bit.

at an angle of about 20° (as at B, Fig. 26), more rather than less, as a thinner edge is apt to “chatter,” or vibrate, if it strikes a hard place in the wood. Many workmen use a rest when grinding; this insures a true bevel. Any device which holds the tool firmly at the same place on the stone will do for a rest.

In whetting the cutter, the screw of the cap iron should be loosened and the cap iron carried back until the screw stops at the top of the slot of the bit, as at C, Fig. 26. The screw is then tightened with the fingers to hold the cap in place; this gives a better grasp of the iron, though some workmen prefer to take the cap off entirely while whetting.

The bevel of the iron should be held exactly upon the surface of the oilstone, as shown at C, Fig. 26, the iron being grasped as in Fig. 27. Keep the right wrist rigid

and allow the arm to swing from the shoulder, bending only at the elbow. In this way the rocking motion may be reduced to a minimum; this is necessary to preserve the bevel. Though the bevel may be maintained better by imparting a short circular motion to the plane iron, or to any edge tool which is being sharpened, it seems

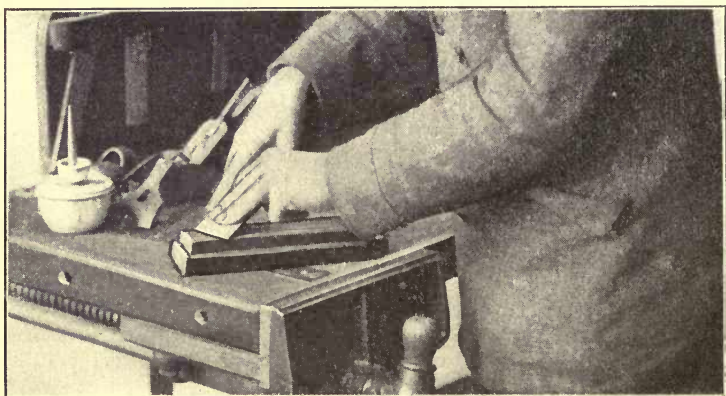


FIG. 27.—WHETTING, OR OILSTONING, THE BEVELED SIDE OF A CUTTER.

an awkward and fussy method of work, and rarely is used by an expert workman. By long practice the mechanic finds that a stroke made nearly the entire length of the stone will impart an edge quicker, and, after the knack has been acquired, that the bevel will be preserved just as well.

Turn the whetstone end for end frequently, and work upon the farther end, as in this way the stone may be kept true much longer than if one place upon it is used all the time. This will also minimize the danger of pulling the tool off from the nearer end of the stone, which will generally make regrinding necessary.

When the beveled side has been whetted, lay the face, or the top, of the iron, perfectly flat upon the stone, as in Fig. 28, holding it down with the fingers of the left hand, using the right hand only to move the iron back and forth. Care should be used that under no circumstances is the face of the iron lifted the slightest degree from the stone.

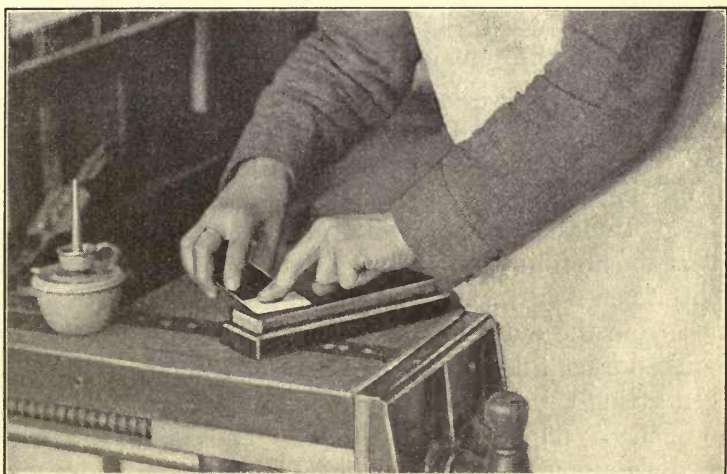


FIG. 28.—WHETTING, OR OILSTONING, THE PLAIN SIDE OF THE PLANE IRON.

At this stage of sharpening a plane iron, the utmost care is necessary that the face of the cutter does not lose its perfectly straight surface at the edge, as the slightest deviation from absolute accuracy at this place will prevent the cap iron from fitting properly. Such a deviation will cause endless trouble, as the shavings will be forced between the cap and the face of the iron (see C. of this topic).

(B.) The shape of the cutting edge of the plane cutter

has an important influence upon its efficiency. Imagine the edge divided into three equal parts: the middle part

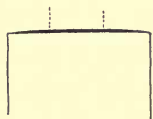


FIG. 29.—SHAPE
OF EDGE OF
PLANE IRON.

should be perfectly straight, or almost imperceptibly rounded; the two outside thirds should be slightly and gradually rounded until the corners of the iron are so short that there will be no danger of their projecting below the face of the plane. This gives the cutting edge an elliptical shape, as illustrated in Fig. 29, which is somewhat exaggerated, as the shape shown is about that which would be seen if a moderately coarse jack plane were held as in Fig. 25.

(C.) In order to insure fine work, the cap iron must be fitted so carefully to the face and to the edge of the cutter that, if necessary, it may be placed at less than $\frac{1}{64}$ th of an inch from the cutting edge, though this would rarely be required except upon very cross-grained wood.

In fitting the cap iron to the top of the cutter, a very fine, sharp file should be used. The filing must all be done upon the under side of the cap iron, at the places where the latter rests upon the face, or top, of the cutter; or, if preferred, the cap may be very carefully bent. Except in cases where there is considerable fitting necessary, however, this second method is not recommended, unless the joint is perfected by the use of a file.

If sufficient care and skill are exercised, a plane may be sharpened and adjusted so finely that a veneer of .01" or less in thickness of bird's-eye maple, burl walnut, ash, or similar wood may be smoothed. It is not wise, however, to spend the time necessary to keep a plane

sharpened and adjusted to do this fine quality of work, as the use of a scraper and sandpaper, or of the latter alone, is the most economical way to smooth woods of such nature.

(D.) To remedy clogging of the mouth, remove the conditions which cause it; simply digging out the shavings is useless. An improperly fitted cap iron is one of the principal causes of trouble; the cutter may be ground so thin that, when it is forced against a knot or hard place, the iron chatters, which allows the shavings an entrance under the cap iron. In this lies the only real advantage of a wooden plane over the modern iron plane, as in the former the iron is much thicker and stiffer. The cap iron may be so thick that it causes the shavings to curl too much, or the frog may be set too far to the front, which will make the mouth too small. This latter may be remedied by moving the frog back, but in a wooden plane, the mouth and the throat must be cut larger in order to allow the shavings to clear themselves properly.

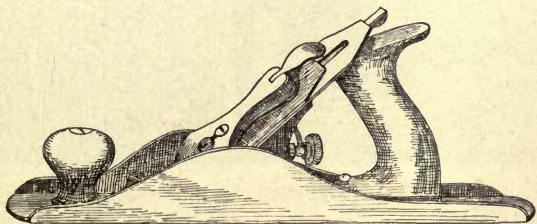


FIG. 30.— JACK PLANE.

15. The jack plane (Fig. 30) generally is 15'' long, and its ordinary use is for the purpose of roughing out a piece of wood for jointing or smoothing. If it is properly sharpened, it may be used as a smoothing plane, or as a

jointer upon small work, as it is capable of doing as good work as any plane.

The jack plane generally is ground more rounding than are the other planes, and the cap set farther back, especially if it is to be used upon rough work.

16. The jointer.—(A.) This tool is from 20'' to 26'' long, and is used to straighten edges and surfaces, or to

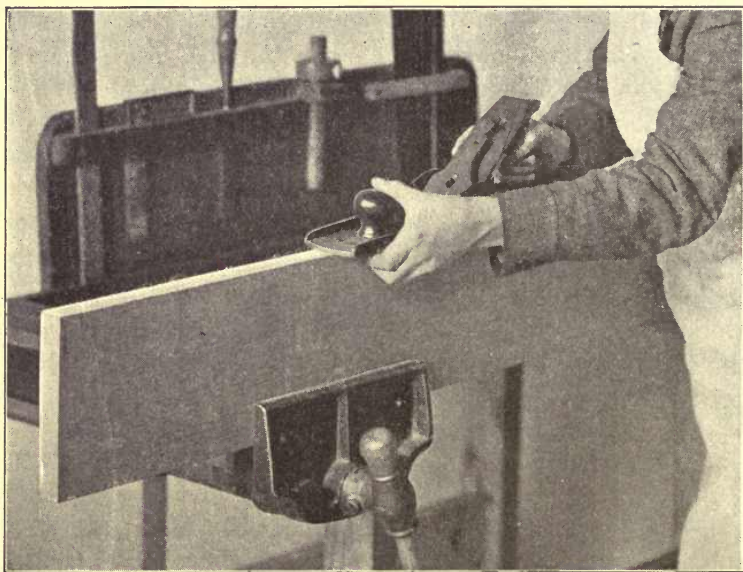


FIG. 31.—METHOD OF GUIDING A JOINTER.

fit them together. The shape of the edge of the cutter of this plane should be but slightly elliptical, less so than that of the jack plane or the smoother, unless the two latter are fitted for doing very fine work.

(B.) In using a jointer for squaring or jointing an edge,

it should be carried to one side or the other of its face, as may be necessary, to take advantage of the elliptically shaped edge of the cutter. This may be done by cutting a shaving thicker on one edge than on the other, thus making the edge of the board square with the face side.

To make a perfectly square edge, the cut should be made in the center of both the iron and the width of the face of the plane. The plane should be held as shown in Fig. 31, with the fingers under the face of the plane, and the tops of the finger nails touching the board lightly, guiding the plane, and keeping the bit cutting in one place upon its edge.

17. The smoothing plane (A.) is of the same type and mechanism as those described above, though it is but 9 or 10'' long; if satisfactory work is expected from it, it must be kept in good order, with the cap iron perfectly fitted. For general work, it is not necessary to spend the time to insure that the plane should be continually in readiness to work upon hard, tough, cross-grained wood, as a plane adjusted to do the latter kind of work well is unnecessary upon softer or straight-grained wood. For ordinary work, the cap iron should be set from $\frac{1}{32}$ '' to $\frac{1}{16}$ '' from the edge of the bit; but for the finest work, the closer to the edge it will fit and allow a shaving to be taken, the finer the work that may be done. No wood used upon ordinary work is so cross-grained or knurly that it cannot be smoothed economically, if a properly sharpened and adjusted plane is used.

(B.) A smoothing plane should cut a shaving as nearly the entire width of the bit as possible; therefore, a very flat, elliptically shaped edge must be main-

tained. In using a plane or any kind of cutting tool, the direction of the grain of the wood should be carefully studied, and every advantage taken of it to facilitate the work.

18. The block plane (A.) (knuckle joint cap, Fig. 32)

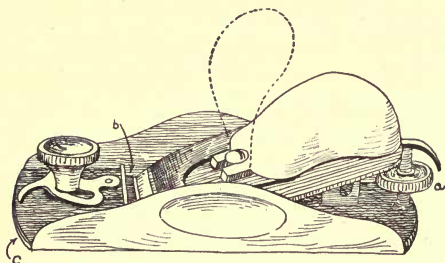


FIG. 32.—KNUCKLE JOINT BLOCK PLANE.

a, adjusting nut ; *b*, movable section ; *c*, face of plane.

is constructed upon a somewhat different principle than the planes above described, as the adjusting nut (*a*) under the cutter at the rear end of the plane is raised or lowered to withdraw or advance the bit, and thus gov-

ern the cut of the tool. The size of the mouth is controlled by a movable section of the face at *b*. This plane has no cap iron, as the use for which it is intended makes it unnecessary. The block plane is used across the end of the wood, at right angles with the general direction of the grain. The iron, or cutter, is so placed in the stock of the plane that its cutting angle is as nearly in line with the cut as possible, the beveled side of the iron being uppermost. By this method of construction, the iron is given more stiffness to

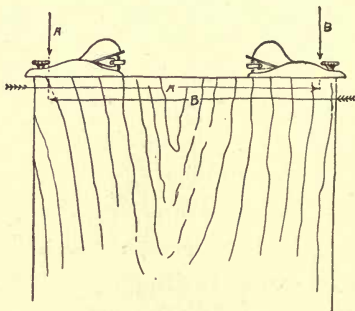


FIG. 33.—USE OF THE BLOCK PLANE.

A, *B*, showing the block plane reversed.

resist the chatter, or vibration, caused by planing end wood.

(B.) In using the block plane, do not make the cuts from edge to edge, or chips will be broken off at the corners. Instead, plane from each edge, and stop the stroke before the other edge is reached; then reverse the plane, and work from the other direction, as shown at *A*, *B*, Fig. 33. Another workman-like way of using the block plane upon small pieces is shown in Fig. 34. Work from each edge, as described above, turning the piece over for each stroke. In sharpening the block plane iron, the edge should be made slightly elliptical, and the bevel carefully maintained.



FIG. 34.—USING BLOCK PLANE UPON SMALL PIECES.

19. The correct position. — (A.) In using planes, or any edge tools, a position should be taken which will furnish sufficient resistance to the pressure required for making the cut, as the pressure should be applied firmly and steadily. With experience, the correct position will be taken involuntarily; the beginner, however, should be

continually upon the watch to overcome his awkwardness.

(B.) The habit of bending from the hips is acquired easily. The young workman should learn to work in as nearly an erect position as possible, for if the bending of the shoulders is persisted in, a permanent stoop will result. Stand facing the work and clear of the bench in order to prevent unnecessary wear of the clothing.

(C.) Do not allow the plane to drop over the end



FIG. 35.—INCORRECT USE OF THE JACK PLANE.

of the board at either the beginning or the end of the stroke, as indicated at A, B, Fig. 35. To prevent this, the hand should be kept upon that part of

the plane which is upon the board; at the beginning of the stroke, the weight should be upon the front end of the plane, as in Fig. 36, and at the end of the stroke, upon the rear end, or upon the handle, as in Fig. 37. Begin and end each stroke with a lifting motion, instead of allowing the plane to drop as it leaves or enters the wood. The plane should be held firmly, not rigidly; do not allow it to jump; this is caused generally by an attempt to take a shaving heavier than the plane should cut, or, if the cap iron is fitted and adjusted properly, by a dull iron. A cutter will jump or chatter if it does not fit solidly against the frog. In drawing the plane back after making a stroke, carry it upon the toe, or upon one corner; do not drag it flat upon its face, as the iron is thereby dulled as much as when it is cutting, or possibly more.

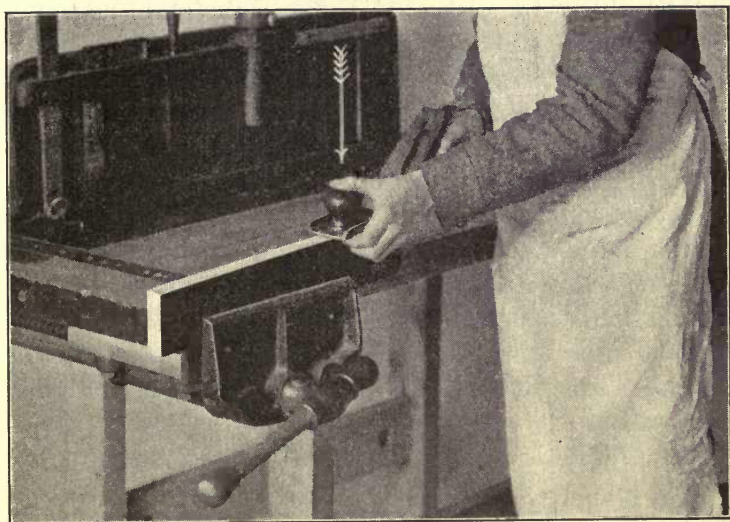


FIG. 36.—BEGINNING THE STROKE WITH A JACK PLANE.

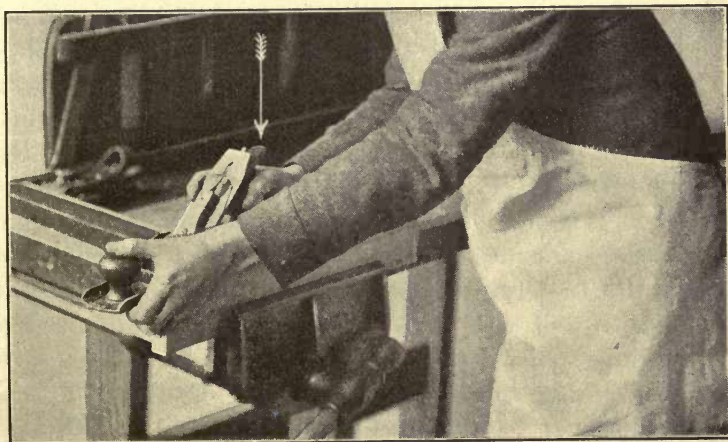


FIG. 37.—ENDING THE STROKE WITH A JACK PLANE.

(D.) Carry the plane parallel with the grain when it is possible, and take no more shavings off than is necessary to attain the desired results. The young workman should make a study of the grain and the peculiarities of the different kinds of lumber upon which he works, losing no opportunity to experiment upon and compare the qualities of every available wood.

(E.) In using edge tools of any kind, little is gained, and much is often lost, by working with dull tools; tools should be sharpened often and thoroughly. This is of the utmost importance, for even with the tools in the best possible order, it will require much care and skill to do good work.

20. Chisels. — (A.) Carpenters' chisels are used for paring and mortising. The paring chisel should be light, smoothly finished, and ground with a sharper bevel than that used for mortising, for which the heaviest chisel is none too strong.

(B.) Chisels are "tanged" or "socket," according to the method by which the blade and handle are joined. The tanged firmer chisel (Fig. 38, A) is the older form, and is not so strong as the more recently designed socket chisel (B). For light work, the tanged chisel is preferred by many, but more commonly the socket chisel is used, as it is stiffer, not so easily broken, and has no shoulder to catch upon the edge of the wood when the tool is used. The beveled-edge chisel (C) is a favorite tool with pattern makers; and the mortise, or framing chisel (D), is designed for heavy use. A set of chisels consists of one each of the following dimensions: $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ ", $\frac{7}{8}$ ", 1", $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", $1\frac{3}{4}$ ", 2".

(C.) A large, heavy chisel, $3\frac{1}{2}$ " or 4" in width, called a "slice" or "slick," is used, like a paring chisel, upon heavy work.

(D.) Handles for paring chisels may be of any hard wood and of any convenient shape, as these should not be pounded upon. Although they are occasionally used for cutting small mortises, it is not a good practice, unless the tops of the handles are protected by leather or fiber tops. Mortising chisels should have handles of the toughest wood obtainable, preferably hickory, with leather nailed with small brads upon the top to protect the wood. If a leather washer is fastened to the handle by a pin or dowel, the wood will in time pound down and the leather be broken out and destroyed, while if bradded upon the handle, the leather may be renewed as often as necessary. An iron ring, or ferrule, is used by many to prevent the handle from splitting, but this will bruise the face of the mallet. A hammer should never be used upon any sort of wooden handle, as the handle will very quickly be destroyed, but a mallet will injure it comparatively little. In fitting the handle to the chisel blade, care should be used that they are in perfect alignment, as otherwise a sharp blow may break the blade.

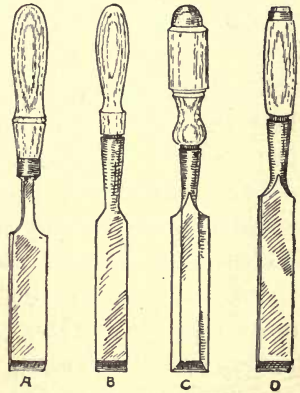


FIG. 38.—CHISELS.

A, tanged firmer chisel; B, socket chisel; C, beveled-edge chisel; D, mortise, or framing chisel.

(E.) In sharpening a mortise chisel, it should be ground

at an angle of not less than 30° , as a thinner edge is liable to break upon coming in contact with a knot. A



FIG. 39. — DRAWSHAVE.

paring chisel may be ground as thin as 20° , as it does not have to stand heavy blows, and a better edge for the purpose may thus be obtained. In whetting a chisel, the bevel must be care-

fully maintained, and the back kept perfectly straight, like the face of a plane iron, as otherwise it will be impossible to work to a line.

21. **Gouges** may, in general, be described in the same way as chisels, except that they are curved instead of flat. The terms "inside" and "outside," used in describing them, indicate whether they are ground upon the inside or the outside of the curve.

22. **The drawshave** (Fig. 39) is often used in cutting curves, in chamfering, and for roughing out work. The patent drawshave, with folding handles, is a safer tool to keep in the tool box, as the edge is protected, but it is not so satisfactory for general work as the ordinary rigid-handled tool. If the latter is used, a piece of wood should be fitted over the edge to protect both it and the hands when the tool is not in use.

23. **The spokeshave** (Fig. 40) should not be used in any place where a plane can be used, but only upon concave or convex surfaces; when used, it may be either pushed or pulled.



FIG. 40. — SPOKESHAVE.

24. **Bits (A.)** are of many different types, the most common being the *auger bit* (Fig. 41). The use of the "worm"

(a) is to draw the bit into the wood, thus making a heavy pressure upon the bit unnecessary. The "lips" (bb) make an incision on the wood below the cut made by the "cutters" (cc), which take the shavings out and into the "twist," this in turn lifting them out of the hole.



FIG. 41.—AUGER BIT.

(B.) Care should be used when boring a deep hole that the bit is removed before the shavings clog in the twist, which will happen if the hole becomes full of shavings that cannot be lifted out. Should clogging occur, do not use a great deal of strength in trying to back the bit out, or its "shank" may be twisted off; it is better to pull it out with a straight pull by means of a lever, if sufficient strength cannot be otherwise exerted, the pull being straight over the center of the bit from the "chuck," not from the head of the bitbrace.

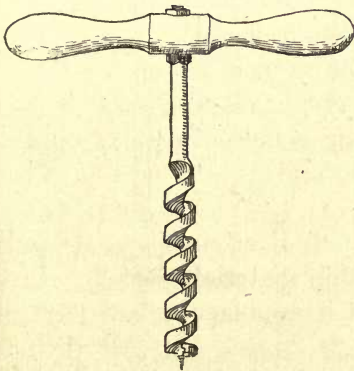


FIG. 42.—CROSS-HANDLED AUGER.

After boring the hole to the desired depth, do not turn the bit backward to remove it, as shavings will be left in the hole, but give it one turn back to loosen the worm, then turn as though boring the hole deeper, lifting under the head of the bitbrace in the meantime, by which process the shavings will be lifted out. These

bits are numbered by 16ths from $\frac{3}{16}$ ths to $\frac{1}{16}$ ths of an inch. Sizes larger than these are known as augers.

(C.) Large auger bits generally are fitted with cross handles, as in Fig. 42, as a bitbrace will not give sufficient leverage to make the bit cut the wood; these are called augers. The form shown is known as a "Ford" auger.

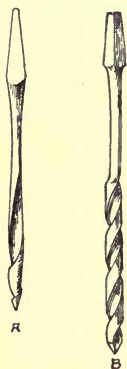


FIG. 43.

A, German bit;
B, twist drill.

(D.) The *German bit* (Fig. 43, A) is used for boring small holes for screws and nails, and has entirely supplanted the gimlet of our forefathers, as its action is much more rapid. Its progression in sizes is from $\frac{1}{16}$ " to $\frac{1}{2}$ " by 32ds of an inch; this tool is also called a *screw bit*.

(E.) The *twist drill* (Fig. 43, B) is a valuable tool; every carpenter should own an assortment of twist drills for use in places where other bits may come in contact with iron. The sizes range from $\frac{1}{16}$ " to $\frac{5}{8}$ " by 32ds.

The round shank drill may be purchased in any size up to 3" by 64ths of an inch.

(F.) The *extension bit* (Fig. 44, A) is a very convenient tool for boring a hole of any size within certain limits, and is at times extremely valuable.

(G.) The *center bit* (Fig. 44, B) is often used in boring holes through thin material which would be apt to be split if an auger bit were used.

(H.) In filing an auger bit, it should be held as shown in Fig. 45, and a small, fine file used on the inside of the lips and the bottom of the cutters; in no case should the outside of the lips be sharp-

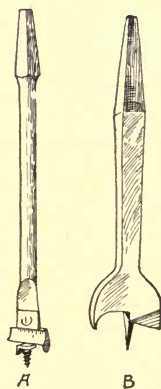


FIG. 44.

A, extension bit;
B, center bit.

ened, as the size of the bit will be reduced. In filing the cutter, be sure that its under side back of the cutting edge is filed enough to clear the wood after the cutter has entered it.

In doing this, it should be remembered that the bit progresses into the wood as it cuts, and unless the under side of the cutter is filed properly, it will bear upon the wood beneath it, back of the cutting edge, and prevent the bit from advancing. To remedy this, be sure that the cutter is kept filed thin, and that the under side is straight from the edge to the beginning of the twist.

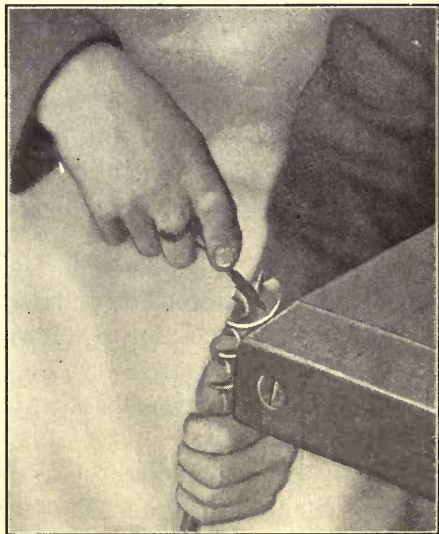


FIG. 45.—FILING AN AUGER BIT.

(I.) If the lips (Fig. 41, *bb*) are filed off, an auger bit bores into the end wood easily.

25. The bitbrace, or stock.—(A.) This tool is used to hold the bit, and to furnish sufficient leverage to turn the bit into the wood. Bitbraces are made of different sizes, and with different devices for holding the “tang” of the bits. A workman should own an 8” and a 10” swing bitbrace, as it is often necessary to use different sizes, or kinds, of bits alternately.

(B.) The ratchet bitbrace (Fig. 46) differs from the ordinary brace only in the ratchet attachment. It is an indispensable tool to an up-to-date workman, as it may

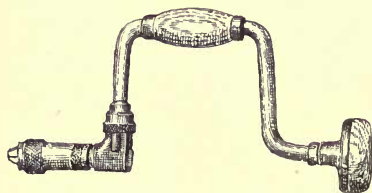


FIG. 46. — RATCHET BITBRACE.

be used in many places where an ordinary brace would be useless; for general work, however, being heavier, it is less convenient than the plain brace.

26. The screwdriver (A.)

is one of the most important tools in a carpenter's kit, and to be of use should be of finely tempered steel; for, if too soft, it will turn over, and if too hard, it will break. The edge should be as thick as the slot of a screw will allow, in order to have as much strength as possible.

(B.) A round-handled screwdriver is not so satisfactory as one with an elliptical or polygonal handle, as it is impossible to obtain as good a grip upon the former as upon the latter; a round handle, planed flat upon the two opposite sides, is quite commonly used.

(C.) *Ratchet screwdrivers* are useful in many places where it is difficult to use two hands, and there are patent quick-action screwdrivers on the market which are suitable only for certain kinds of light work, as what is gained in speed is lost in power. The screwdriver bit is a short screwdriver blade, tanged to fit a bitbrace; it is essential in doing economical work, as screws may be driven much more rapidly than by hand, and it is also valuable on account of its greater leverage in driving heavy screws.

27. **Compasses, or dividers** (Fig. 47), are used to draw circles and curves, and for spacing and scribing, by which is meant the process of fitting a piece of wood to an uneven surface. *Calipers* (Fig. 48) are used to measure the outside of a round or oval object. Those shown are known as "outside" calipers; "inside" calipers, or those used for measuring the inside of a hole, have straight legs. These tools ordinarily are not considered a part of a carpenter's kit, as they are generally used upon work requiring more exact measurements. Woodworkers' tools are graded to sizes, generally nothing finer than 16ths of



FIG. 47.
COMPASSES.

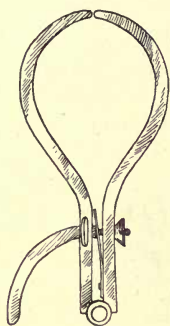


FIG. 48.
CALIPERS.



FIG. 49.
PLIERS.

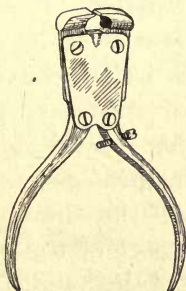


FIG. 50.
NIPPERS.

an inch; hence, the ordinary methods of measuring will usually give sufficiently accurate results.

28. **Pliers.**—(A.) These are indispensable little tools (Fig. 49), and every workman should own a pair. Those combining several tools are most useful; cheap tools of this sort are usually worthless.

(B.) *Nippers* (Fig. 50) are made to cut wire, but not to pull nails. Being tempered for cutting, those of good quality are hard and brittle, lacking the toughness neces-

sary to pull nails, for which work a cheap pair of nippers may be purchased.

29. The scraper is one of the most useful tools in the kit of the carpenter who works upon hard wood. This tool may be purchased, or made of a very hard saw; it

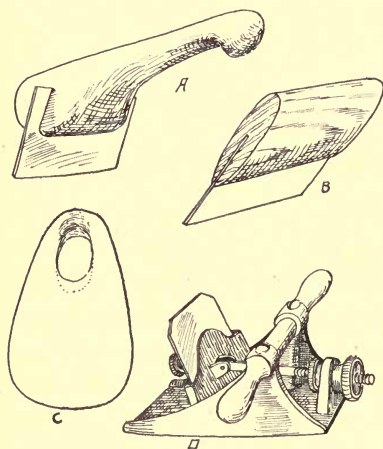


FIG. 51. — SCRAPER.

A, B, handles for scraper; C, leather palm; D, scraper plane.

must be of hard, tough steel, or the edge will not last. A scraper should be about 3'' × 5'', which is a convenient size for grasping with the hand. Many workmen make handles for their scrapers (Fig. 51, A and B), but cabinet makers, and others who use them continually, generally prefer to use them without handles. If a large surface is to be scraped, it is well to have a handle of a leather palm (Fig.

51, C). This is a piece of leather of suitable size and shape to protect the hand from the heat generated by the action of the scraper in cutting; the thumb is passed through the hole, and the broad part of the palm hangs between the scraper and the thick of the hand. For scraping floors, a scraper plane (Fig. 51, D) will be found valuable, though if much of this work is to be done, it will be the best economy to purchase one of the forms of floor-scraping machines.

30. Edges. — There are two forms of edges used in

sharpening scrapers,—the *square* and the *beveled* edge; in sharpening either of these, the edge should be filed, whetted, and turned with a burnisher. This imparts a wire edge, indicated in Fig. 52, *A* and *B*, which shows enlarged views of the two forms of edges of scrapers. If the eye glances along the edge of a properly sharpened scraper, the edge will appear slightly curved; this edge must be given it by filing. After the scraper is filed, each corner which is to be turned must be whetted to a perfectly keen edge upon an oilstone, as the object of sharpening a scraper is to “turn” this edge at an angle with the sides of the scraper.

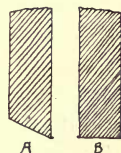


FIG. 52. —
EDGES OF
SCRAPERS.

A, beveled
edge; *B*, square
edge.

By “turning” the edge of a scraper is meant pushing the particles of steel, which form the corner, over, so that they will form a wire edge which will stand at an angle with the sides of the scraper. When the edge has been skillfully turned, it will cut like a very finely sharpened and adjusted plane, and will work either with or against the grain without tearing the wood.

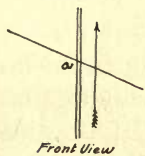


FIG. 53. —
ANGLE OF
BURNISHER
WITH SIDES
OF SCRAPER.

Notice carefully the angle of the burnisher with the sides of the scraper, as at *a*, Fig. 53, and as in Fig. 54, which indicates approximately the angle at which it should be held across the edge when seen in the view illustrated of either a square or beveled edge

scraper, the vertical lines indicating the scraper. The stroke must be from the bottom, up, as indicated. At *A*, Fig. 55, is shown the top view of the burnisher as it makes each of the strokes in turning the edge of a square edge scraper; notice that the burnisher swings in an

angle of about 15° , one stroke only being made at each angle.

At *B*, Fig. 55, is shown the method of turning the edge of a bevel edge scraper; the student will notice that the

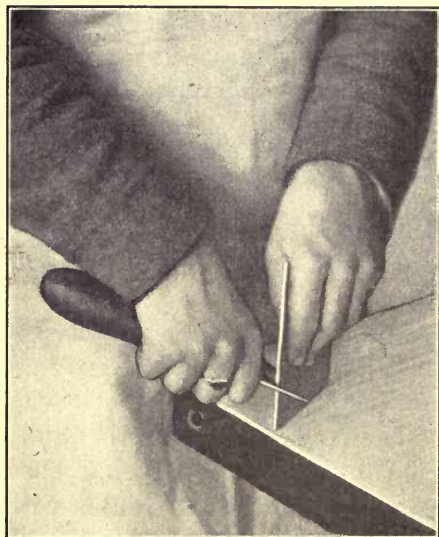


FIG. 54. — METHOD OF GRASPING SCRAPER FOR SHARPENING.

angles are similar to those shown at *A*, except that the first stroke is made at nearly the same angle as the bevel of the scraper. An edge may often be turned at one stroke, and more than three should rarely be necessary. If more than three are made, the edge may be turned too far, which is worse than not being turned enough. The strokes should be made in the order

indicated by the figures of the angles of the burnisher; otherwise it will be difficult to obtain satisfactory results.

The amount of pressure necessary to apply at this stage of the work cannot be described, but can only be discovered by practice. A steady, moderate pressure is all that is needed, but care should be used that the angle of the burnisher does not change during the stroke. This will give an edge suitable for common

counter, or table, tops, for hardwood floors, and similar work, if the skill to use the burnisher properly has been acquired.

The burnisher should be slightly lubricated with oil, or with the end of the tongue, as this assists it to slide over the edge of the scraper without scratching.

If a scraper is to be used upon very fine work, a different shaped edge should be made; it should be whetted to four perfectly square and keen corners, each of which will furnish an edge. This is a more difficult method of sharpening a scraper, but it gives four edges suitable for fine work.

The edge should be turned by carrying the burnisher as shown at *A*, Fig. 55, making the strokes at the differ-

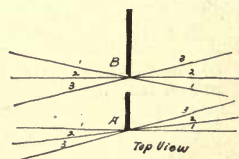


FIG. 55. — TOP VIEWS OF THE ANGLES OF THE BURNISHER.

ent angles in the order indicated by the numbers. In sharpening any scraper, care should be used that no strokes are made back of the square, as stroke *bc* of Fig. 56. Keep the burnisher pointing down all the time, as indicated at *a*, Fig. 53, as in this lies the chief difficulty. Two or three strokes should be sufficient to sharpen the scraper.

To turn the edge of a scraper properly, a burnisher is necessary. This tool should be made of the hardest steel, and is often made by the workman himself from an old file, ground perfectly smooth and polished. Perhaps the most satisfactory burnisher within easy reach of the woodworker may be made from a nail set, which may be fitted to a handle and ground to an awl point. The back of a narrow chisel or gouge may be used, though these are rather clumsy. The burnishers found in stores are generally

of little value, as they are apt to be soft, and any steel which can be cut with a file is useless as a burnisher for sharpening scrapers, as the scraper will cut into it, instead of turning over.

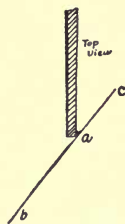


FIG. 56. — ANGLE TO BE AVOIDED IN SHARPENING SCRAPER.

If satisfactory results are not obtained, there may be several causes: the scraper may not be of just the right temper or texture; the burnisher may be soft or rough; the edge may not have been turned over evenly, or it may have been turned over too far, as indicated in an exaggerated way at *a*, Fig. 56, which is the result of carrying the burnisher around too far, as shown by the line *bc*. This may be remedied by using the awl point as shown at *d*, Fig. 57, holding the scraper and burnisher in about the same relative positions as indicated, and guiding the burnisher by the thumb, which should be carried on the square edge of the scraper, moving with the burnisher its entire length. In this way the edge may be turned back to its correct angle, when a very light touch in the usual way will generally make the desired edge.

If either the scraper or the burnisher is not of the right texture, throw it away, as it is worthless. If the burnisher is rough, it may be made smooth upon an oilstone. If the edge of the scraper is rough, it may be turned back again by laying the scraper flat upon the bench, the rough side up, and the burnisher passed over it several times; then proceed as with a new edge. In general, this is not so satisfactory as it is to file, whet, and sharpen the edge all over

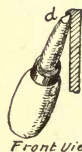


FIG. 57. — TURNING BACK THE EDGE OF A SCRAPER.

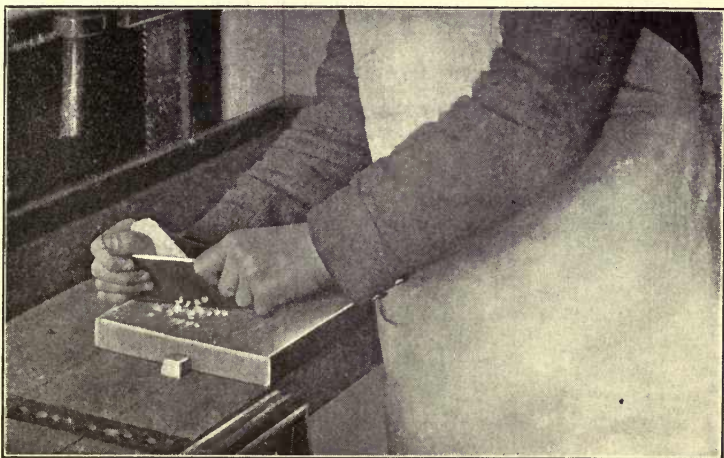


FIG. 58.—METHOD OF GRASPING THE SCRAPER WHEN WORKING UPON A BROAD SURFACE.

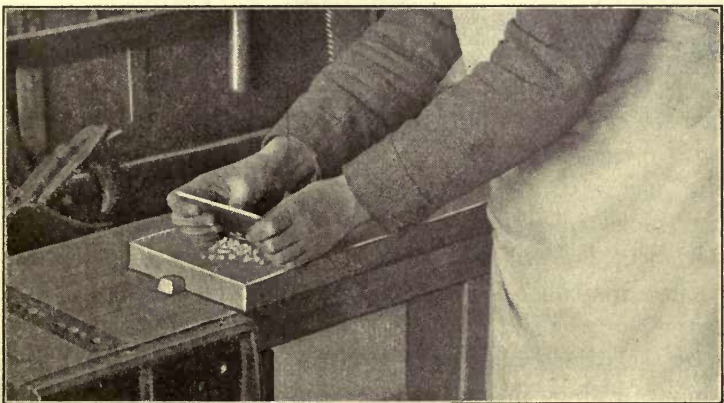


FIG. 59.—METHOD OF GRASPING THE SCRAPER WHEN WORKING WITHIN A SMALL AREA.

again, especially if the corner has been turned several times.

Though it may seem from the above explanation of the methods of sharpening scrapers that it is a very complex

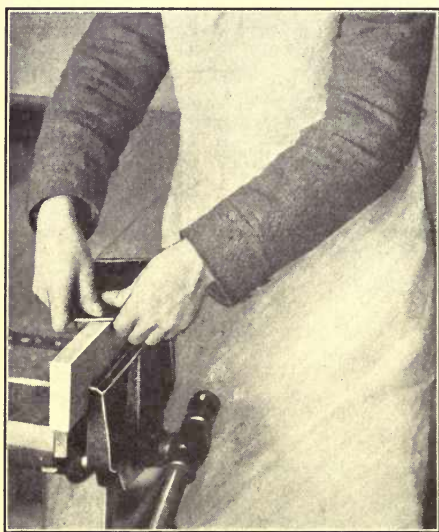


FIG. 60. — METHOD OF GRASPING THE SCRAPER WHEN WORKING UPON AN EDGE.

operation, it will be seen that it is not a difficult matter, if it is once worked out. Usually it demands a little time and practice to acquire the knack that will make it possible to do the sharpening surely and well.

In using a scraper, it may be grasped as shown in Figs. 58, 59, 60, as best suits the work being done, and the strokes should be with the grain. In using this tool, as in

the use of most others, the easiest way generally is the most efficient. As the young workman gains experience, he will gradually acquire the correct methods to use his tools for all the various purposes within their scope.

31. Nail sets are for the purpose of “setting” the nails, or for sinking them below the surface of the wood; and in order to stand the hard usage to which they are subjected, they must be very carefully tempered.

The best form of nail set is that which has a cupped or hollow point, as it is not so apt to slip off of the head of the nail.

32. **Wrenches** are of many kinds and patterns and of every conceivable use, but that known as the "monkey," or "Coe's," wrench (Fig. 61) is perhaps the most convenient for general work and has not been supplanted by any of more recent invention.

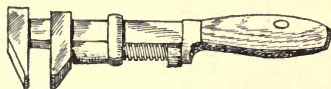


FIG. 61.—MONKEY WRENCH.

33. **Handscrews (A.)**, if of good material and well made, will stand any legitimate use, and if properly used and cared for, will last a lifetime. However, a novice or a careless workman often destroys them rapidly by allowing the jaws to be under strain while in the position shown in

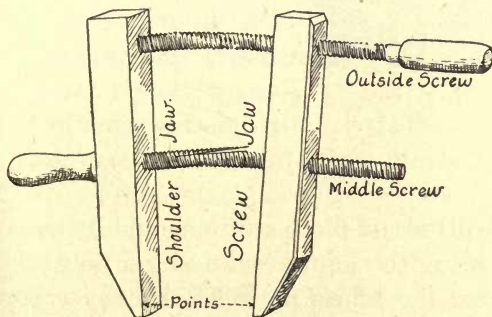


FIG. 62.—EFFECT OF THE UNSKILLFUL USE OF A HANDSCREW.

Fig. 62, which will probably break the middle screw, and perhaps both screws.

(B.) In using handscrews for gluing, the jaws should be set to nearly the size of the material which is to be placed between

them, before the glue is spread. In placing the handscrews upon the work, the outside screw should be turned back so that it will not prevent the jaws from being

slightly closer at the outside screw than at the points. By this method the strain which is applied in setting up the outside screw will bring the jaws parallel, which is the only position in which handscrews should be allowed to remain.

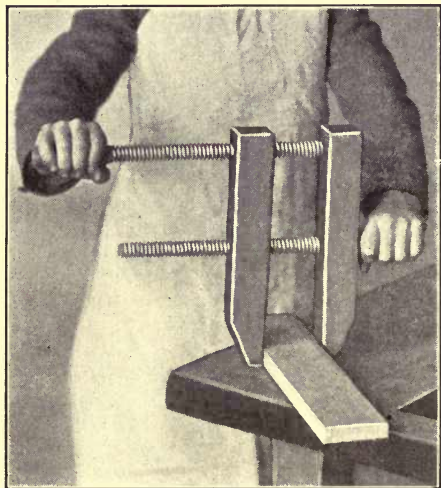


FIG. 63.—CORRECT USE OF THE HANDSCREW.

In opening or closing a handscrew, the middle screw should be held in the left hand, and the outside screw in the right, as in Fig. 63; the screws should then be grasped so that they will not turn in the hand and the handscrew revolved in the desired direction. Never put unnecessary strain upon handscrews, nor leave

them with a heavy strain upon them for a very long time.

If the work is well fitted, no more strain should be used than is necessary to bring the joints well up, and no work should be glued unless the joints fit well. In any case, the outside screw should be turned back a quarter or a half a turn after the glue has set; this will relieve the strain, and add much to the life of the handscrew.

In gluing work which requires several handscrews to hold it while the glue is setting, the handles of the outside screws all should point one way. This allows the work to

be handled much more easily, as the handles of the middle screws will form an even bearing upon the floor. If this is not done, the outside screws are apt to be broken when a heavy piece of work is being glued and handled, since the weight of the work will rest upon the screws which bear upon the floor.

(C.) Before using new handscrews, the screws should be treated with beeswax and beef tallow, or with black lead mixed with oil or with wax. The latter compound is very dirty; the former lubricates the screws perfectly. The screws should be heated, and the lubricant applied hot.

34. (A.) A grindstone of good quality, from 20" to 26" in diameter, is indispensable to a woodworking shop, and should be used frequently, as the efficiency of cutting tools is much increased if they are kept well ground, and much time may be saved in whetting them.

(B.) In selecting a grindstone, be sure that it is true and round, and of a coarse, even grit, which can be quite satisfactorily determined by examining several and selecting the coarsest, as that will doubtlessly be a fast cutting stone.

(C.) The stone should be carefully centered and mounted upon a frame. The face may be kept true by means of a file or other hard steel being held against it as it revolves, or a piece of $\frac{1}{2}$ " or $\frac{3}{4}$ " gas pipe revolved from side to side of the stone as it is turned. Never allow a stone to rest with one side in the water, as it will be made softer and heavier upon that side, and soon worn out of true.

(D.) Do not use one place upon the surface of the stone continually, as a groove will quickly be worn there; in-

stead, keep the tool moving from side to side. If properly cared for, a stone will hold its face indefinitely.

35. Emery, corundum, carborundum, and other artificial abrasive wheels have in many cases supplanted the grindstone, as they cut much more rapidly. Any one not accustomed to using them must be careful that the temper of the tool is not destroyed, as the wheel runs at a high

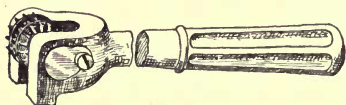


FIG. 64.—EMERY WHEEL DRESSER.

rate of speed, and a tool in unskillful hands is easily burned. To avoid this, the tool should be held lightly but firmly against the stone,

and frequently dipped in water to cool it. If an emery wheel burns badly, it may be because it needs dressing; for this purpose a diamond emery wheel dresser is the best, but on account of its cost, various devices have been patented to accomplish the same result, one of which is illustrated in Fig. 64.

36. Whetstones.—(A.) These are used to give to a tool the keen edge necessary to cut wood smoothly. The natural stone in most common use is the “Washita stone,” which is quarried in the Ozark mountains, and is thought by many to be the best natural stone for the general use of the woodworker; it is fast cutting, and when of the best quality is of even texture.

(B.) Many workmen prefer an “Arkansas stone,” as it is finer and harder than the Washita. It is also more expensive, however, and is better adapted to the use of woodcarvers and engravers than to the use of woodworkers in general. It is usually not so fast cutting as the best of the Washita stones, but a finer edge may be obtained by its use. There are other natural

stones, but none so generally used as the above. The purchase of a natural stone is to a great extent a lottery, as only about one stone in ten has a perfectly even texture, is free from cracks, and has reasonably good cutting qualities.

(C.) If a stone needs truing, lay a piece of coarse sandpaper upon a board, and rub the stone over it until it has been ground down. The best place, however, to true up a whetstone is upon the horizontal stone of a marble worker; this is a large grindstone, several feet in diameter, mounted on a vertical shaft, upon which are placed pieces of marble to be ground to a flat surface.

(D.) *Artificial oilstones*, made of emery, corundum, carborundum, and other artificial abrasives, are coming rapidly into use, and, as in the case of grindstones, eventually will supplant all others in many occupations, as they cut faster than any natural stone, may be made of any degree of fineness, and are of absolutely even texture. They are also able to resist many accidents which would destroy a natural stone.

(E.) *Slip stones* are used to sharpen gouges and curved tools of all kinds, and may be made in any desirable shape. An oblong stone, $8'' \times 2'' \times 1''$, is the size of stone in most general use by the woodworker, and should be fitted into a box or piece of wood with a cover to keep it clean. It may be laid either flat or on its edge, as suits the workman, though the stone may be kept true more easily if it is set on its edge.

(F.) The use of the oilstone is described under topic 14, A. The oil used should be a kind that will not gum; its purpose is to prevent the glassiness which is caused by

the friction of the tool over the stone. Common machine oil is used by many, lard oil by others, while kerosene, or coal oil, is claimed by many workmen to be the only oil suitable for use upon an oilstone. Any one of these oils will give satisfactory results, but kerosene keeps the stone cleaner, thereby adding to its efficiency, and for this purpose lubricates quite as well as any of those above mentioned.

37. (A.) Files are used for many purposes by woodworkers. An assortment consisting of 4" and 6" slim taper, or three-cornered, files; 8" and 10" flat, or bastard, files; 8", 10", and 12" round files; and 8" and 12" half round wood files and rasps should be in every carpenter's kit. The 4" slim taper files should be used upon the finer saws, and the 6" upon the coarser ones, though the latter are used by some workmen for both saws. Upon jobbing work it is necessary to have a few warding and knife files to use upon keys and odd jobs, and also to sharpen bits.

Files and rasps are made of every shape and size, and for every purpose. Wood files usually are tempered to stand lead or soft brass, and should never be used upon anything harder.

In drawing a file back between the cuts, do not allow it to drag, as it is injured thereby about as much as when it is cutting.

(B.) There are a great many other tools and appliances used by the woodworker with which the workman should be familiar, but it is not necessary to describe them, as the above-mentioned are the most essential tools common to all forms of woodworking. There is no important principle involved in the construction, care, and

use of woodworking tools which is not discussed in this chapter, and the student who becomes thoroughly familiar with the matter treated will have little trouble in learning to handle other tools.

38. **Saw filing.** — (A.) This is an accomplishment which every young woodworker should master, as its

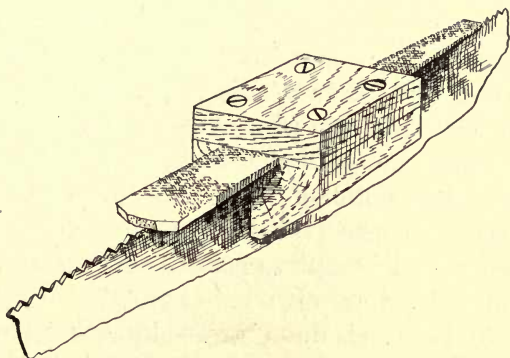


FIG. 65. — JOINTING A SAW.

possession will save expense and inconvenience, and add much to his efficiency as a workman.

(B.) The first step in sharpening a saw is to examine the edge carefully to see if the teeth are of an even length; if they are not, they should be jointed. This is done by using a flat file held perfectly square in a block, as shown in Fig. 65. One or two light strokes usually will be enough to make all the teeth of the same length. The edge of the saw should round slightly in the middle, say about $\frac{1}{8}$ " for a 24" or a 26" saw. If the edge is perfectly straight, it should not be jointed to this shape at once, but a little at each time for several filings.

(C.) After jointing the saw, be sure that it is properly

set. This may be done by a *saw set*, of which there are several patterns in use; these are all of two types, the

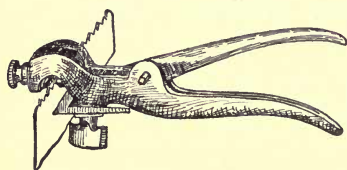


FIG. 66.—HAND SAW SET.

hand set (Fig. 66) and the *anvil set* (Fig. 67). Either of these forms is efficient, but as it is more convenient, the hand set is more commonly used. Do not give the saw

too much set, as it will not cut smoothly, but will break the wood badly on the back side of the cut; there is also greater danger of breaking the teeth, and as more wood is cut out, more muscle must be applied. The point of the teeth only should be set, and care should be used that the blade of the saw is not sprung, which will be apt to result from setting the teeth too far from the point.

A saw to be used upon green lumber should have coarser teeth and more set than one which is to be used upon thoroughly dry, seasoned wood. A panel saw intended for use upon fine finishing work usually is ground so thin upon the back that it needs little or no set. Some workmen set a saw so heavily that it will do for several filings; while this is satisfactory for a soft saw to be used upon common work, it is not a good plan to treat a fine, hard saw this way, though the latter may be touched up once or twice.

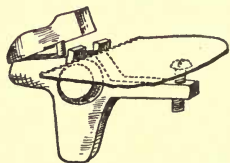


FIG. 67.—ANVIL SAW SET.

(D.) In filing, it is important that the file should be carried at the same angle the entire length of both sides of the blade. For a cutting-off saw, the file should be

carried at an angle with the side of the blade of from 60° for soft wood to 70° for hard wood, as shown in Fig. 68; and for general work, at an angle about halfway between the two. The file may be carried horizontally, as at *aa*, Fig. 69, which makes all the teeth of the same size; as at *A*, Fig. 70; or it may be carried as at *bb*, Fig. 69, which will make the teeth of the shape shown at *B*, Fig. 70. The third method is preferred by many workmen, as it allows the file to run more smoothly, thus lengthening its life a little. There is no difference in the efficiency of the saws filed by these methods, but if filed as at *bb*, Fig. 69, it is more difficult to keep the teeth of the same size. and to make a good-looking job.

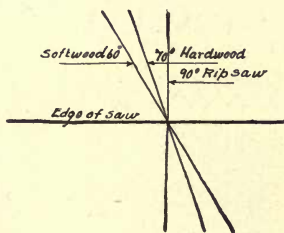


FIG. 68.—ANGLE OF THE FILE WITH THE EDGE OF THE SAW.

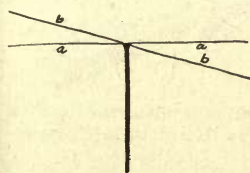


FIG. 69.—ANGLE OF THE FILE WITH THE SIDES OF THE SAW.

to the hook which it is desired that the teeth shall have. The more hook a saw has, the faster it will cut, but the cut will be rougher in proportion. Experience is necessary to discover just the right angles at which the file should be held; after considerable practice, the file will

drop naturally into the correct position.

File every tooth upon each side of the saw to a perfect point, one half of the filing being done from each side; file the entire length from one side, then reverse the saw and file from the other side. This cannot always be the exclu-

sive practice if a saw is in very bad shape, because if the teeth are of uneven sizes, care must be used, and more



FIG. 70.—RESULTS OF
FILINGS AS AT *aa* AND
bb, FIG. 69.

filed from some teeth than from others. It may, in such a case, be necessary to go over the saw two or three times, but it should be done very carefully, so that the bevel of the teeth may be preserved and their length kept the same. Observe each tooth, and press toward the point or the handle of the saw, as may be necessary. The file should be carried with its point toward the point of the saw, filing the cutting or the front side of the tooth of the farther side of the saw, and the back of the tooth next ahead on the nearer side with the same stroke. If the point of the saw is carried toward the handle of the saw, it makes the teeth chatter, and upon a hard saw, may make them break. It also causes an excruciating noise, and shortens the life of a file, as the continuous chatter against its teeth will soon break them and destroy the file.

A ripsaw requires more set than a cutting-off saw, and if, as usual, the file is carried square with the blade both ways, the saw may be filed from one side.

After a saw is filed, it should be laid upon a perfectly flat surface, and given a light touch with a flat file or a whetstone, to remove the burr caused by the file, as in Fig. 72.

The teeth of the compass saw should be a combination

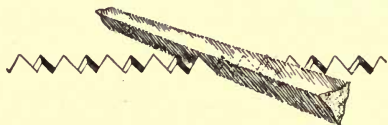


FIG. 71.—METHOD OF CARRYING A FILE
TO OBTAIN THE HOOK OF A CUTTING-
OFF SAW.

of the rip- and the cutting-off saw, as it does the work of both as occasion requires. The teeth should be nearly as hooking as those of a rip-saw, and the front teeth filed at an angle of about 80° with the side of the saw. In filing the back of the teeth, the hand should be carried a

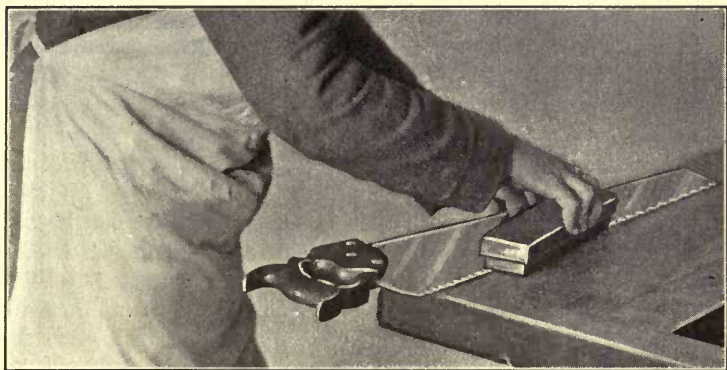


FIG. 72.—REMOVING THE BURR AFTER FILING A SAW.

little lower than horizontal. Figure 17, *C*, shows three views of the teeth of a compass saw.

SUGGESTIVE EXERCISES

1. What should be the quality of all mechanics' tools? Is a good, serviceable tool always finely finished? Are tools made especially for some dealer always reliable? What is the safest method to follow in buying tools? How may the efficiency of a tool be known?
2. Describe two forms of benches. Describe a modern vise.
3. Describe the rule in common use.
4. For what is the try-square used? Why should special care be used in purchasing one? How may a square be tested?
5. Compare the steel square with the try-square.
6. Describe the bevel and its use.

7. For what is the gauge used? Should the graduations of the gauge be depended upon in setting it? What special form of gauge is useful?

8. What will be the result if the head of a hammer is not properly tempered? Why is the eye shaped as it is? How is the handle fastened to the head? Describe the wood necessary for a hammer handle. How should a hammer be hung? How should nails be driven so that they will hold the best? What should be guarded against in driving up ceiling or matched boards? How and why should nail heads be sunk below the joint surface?

9. For what is a hatchet used? Describe two ways of sharpening a hatchet.

10. What is the principal use of a mallet? Describe and compare two forms of mallets.

11. What are the two parts of a saw? Describe the use of a rip saw. After what tool is it modeled? After what tool are the teeth of a cutting-off saw modeled? What kind of saw combines the teeth of both? For what is it used? Why is it made of softer metal than are other saws? Describe a saw adapted to jobbing work. Describe the backsaw. How can the blade be straightened if it is sprung? What kind of saw is used for fine work? How should the thickness of the back of a saw compare with its cutting edge? What is gained by this? What test should the blade of a high-grade saw be able to stand? What are the best sizes for saws? Compare the practical features of a hard saw with those of a medium hard saw. How should a saw be held? How much force should be used upon a saw? How do some workmen change the handles of their saws to make the saws run more easily?

12. Describe the knife commonly used by the woodworker. Why is the form of blade used in manual-training schools more suitable for whittling than the form used by the woodworker?

13. Compare the old-fashioned with the modern planes. Describe the mechanism of the modern plane and its action. What should be the condition of the face of a plane? How should a plane be held so that one may see the adjustment of the cutter?

14. Of what use is the cap iron in grinding a plane bit? How may a grindstone be prevented from wearing unevenly? Upon which side of the bit should all the grinding be done? At what angle should it be

ground? What is the objection to grinding a bit too thin? Where should the cap iron be while whetting? How should the bevel of the bit be held upon the stone? Describe the correct action of the arm while whetting. How should the whetstone be prevented from wearing unevenly? What motion should be avoided in whetting? What is the correct shape of the edge of a plane iron? What is the use of the cap iron? What is apt to result if the cap iron is too thick?

15. What plane is used generally for rough work? In what way does the edge of its iron differ from that of other planes?

16. What plane is used for straightening edges and surfaces? What should be the shape of the edge of the iron of this plane? How should a plane be carried to joint an edge square?

17. What plane is used in smoothing fine work? What should be the position of the cap in smoothing hard, cross-grained wood? How should edge tools of all kinds be used in relation to the grain?

18. Compare the construction and the use of the block plane with the above planes.

19. What position should be taken when at work with edge tools of any sort? Should the workman bend from his hips or from his shoulders? What should be guarded against at the beginning and the end of the strokes of a plane? Is it ever economy to work with dull tools? How should a plane be drawn back after a stroke?

20. What are the two forms of chisels? Describe the peculiarities and uses of each. Describe a durable form of chisel handle. Should a mallet or hammer be used in pounding upon a chisel handle? Why? Describe and give reasons for the difference in the grinding of the paring and the mortising chisel. Describe a set of chisels. What is a slice, or slick?

21. Describe a gouge. What is the difference between an inside and an outside gouge?

22. Describe the form and uses of a drawshave. Compare the utility of the rigid- with that of the folding-handled drawshaves. How should the edge of a rigid-handled drawshave be protected?

23. Describe the form and the use of a spokeshave.

24. What is the form of bit in most common use? Describe the different parts of an auger bit and their functions. How may the clogging of a bit be prevented? If a bit should become clogged in a hole,

how should it be drawn out? Describe the form and the use of a German bit; of a twist drill; of an extension bit; of a center bit. Describe the method of sharpening a bit. Demonstrate. What part of a bit should never be filed? Why?

25. Describe the form and the use of bitbraces. Describe the ratchet brace. Which is the more convenient brace for common use?

26. What should be the shape and the temper of the point of a screwdriver? What should be the shape of the handle? What is the value of a screwdriver bit?

27. Describe the use of compasses; of calipers.

28. Describe the use of pliers. What is a good form for common use? Should wire-cutting nippers be used to pull nails? Why?

29. For what is a scraper used? What is the best size for a scraper? Describe handles for scrapers. Describe a leather palm and its use.

30. Describe a burnisher. How should a scraper be sharpened for rough work? For fine work? How may a burnisher be used when the edge of the scraper has been turned over too far, or when the edge is not sufficiently keen? How should the scraper be used in relation to the grain?

31. Describe the best form of nail set.

32. What is the form of wrench in most common use?

33. How long ought hand screws to last? What should be the position of the jaws when in use? Which screw should be set first? How should hand screws be treated to make them work more easily?

34. What are the characteristics of a good grindstone? How should a grindstone be trued?

35. Compare emery wheels and grindstones. What should be guarded against in the use of an emery wheel?

36. Why is it necessary to use a whetstone? What kind of stone is commonly used? What is a finer kind of stone? Compare the two kinds. How may whetstones be trued? What kind of stones are coming into use? Compare the wearing qualities of stones laid flat with those laid edgeways. What forms of stones are used for gouges? What kinds of oils are used for oil or whetstones?

37. What kinds of files are used for saw filing? Describe the files generally used by woodworkers. Describe wood rasps and files.

38. Describe the jointing of a saw. What should be the shape of

the cutting edge of a saw? Describe the purpose, and demonstrate the process, of setting a saw. Compare the set of saws for coarse and fine work. At what angle with the sides of the blade should a file be carried in filing a cutting-off saw? Compare the results of carrying the file horizontally with those of an upward inclination. At what angle with the sides of the blade should the file be carried in filing a rip saw? If the saw is in bad shape, should the attempt be made to bring it to a finished point when going over it the first time? What should be the direction of the point of the file while it is cutting? Compare the set of the rip saw with that of the cutting-off saw. Compare the teeth of the compass saw with those of others.

CHAPTER II

WORKING DRAWINGS

39. Use and purpose of working drawings. — (A.)

It is essential to the success of a workman of the present time that he should be able to read ordinary working drawings readily, and to take measurements from them intelligently. He should also understand the relation between the scaled drawing and the work that he is to produce from it.

(B.) The difference between a photograph, or a perspective view, and a working drawing, lies in the fact that the former shows the object approximately as it appears to the eye, and is an end in itself; while a working drawing is made with but slight regard for artistic effect, and is simply a means to an end. In other words, the purpose of a working drawing is to convey to the mind of the workman, in the plainest and simplest manner possible, the idea which is in the mind of the draftsman.

40. Three-view drawing. — Any object to be drawn may be shown generally by three views; for instance, let us assume that the perspective sketch of the cross in Fig. 73 represents the idea, or the mental image, conceived in the mind of the draftsman, and of which he wishes to make a drawing as a means to the end of having the cross built.

In his mind he takes a position directly in front of the cross, and imagines that every part of its face is at exactly right angles with a line from his eye. This eliminates perspective, and he proceeds to draw the sketch shown in the front view of Fig. 74.

In doing this, he imagines a transparent plane between his eye and the mental image of the cross, at right angles with the line of vision, which we will represent by the plane *abcd* of Fig. 73.

Using his paper as that plane, he draws upon it the lines, which, in his mind's eye, he sees projected there from the cross, as illustrated in the front view of Fig. 74. This completes the front view, and he must perform the same operation for the top view, imagining himself above the cross and looking directly down

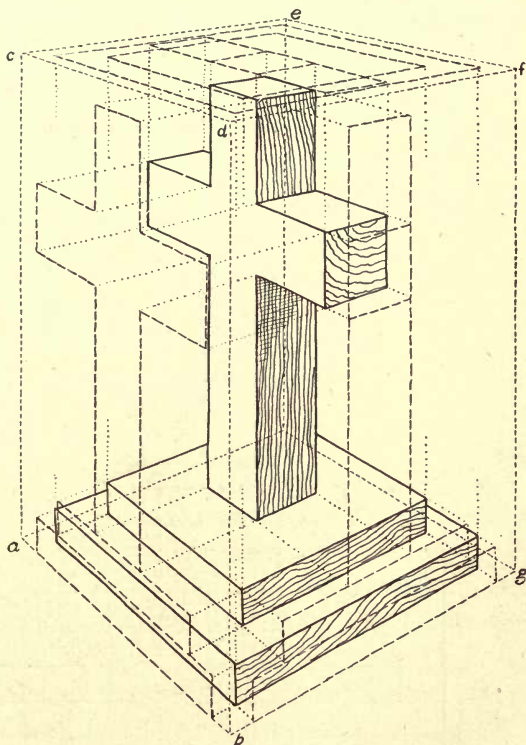


FIG. 73.—PERSPECTIVE VIEW OF A CROSS, ILLUSTRATING THE THREE PLANES OF PROJECTION COMMONLY USED.

upon it, using the transparent plane $c d e f$, as his basis. The resulting lines are shown upon the top view of Fig. 74. The same method is followed in drawing the right side view of Fig. 73, working to plane $b d f g$. This same process could be continued around the six sides of the transparent

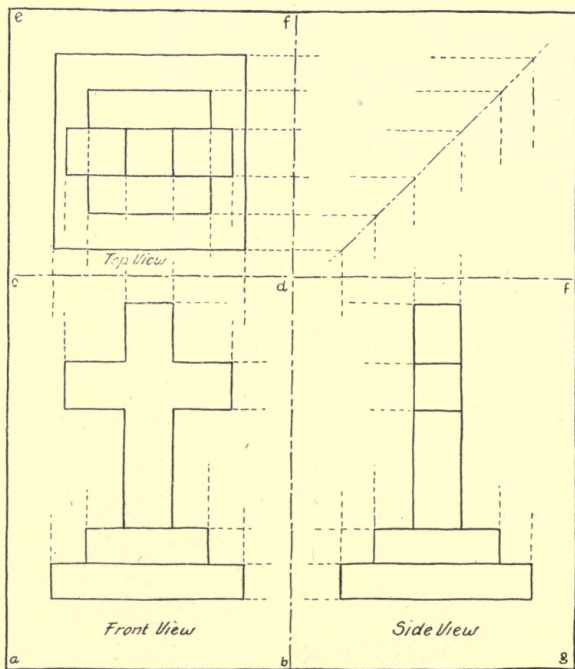


FIG. 74. — WORKING DRAWING OF CROSS, ILLUSTRATING METHOD OF SHOWING THREE VIEWS UPON ONE PLANE.

box inclosing the cross, but these, as well as the drawings showing the sections of the object, are necessary only when three views will not describe the object sufficiently. The elevations and floor plans of a house, and its sections, are an instance where more than three views are essential.

Frequently two views will adequately convey the draftsman's ideas, as in Fig. 75.

Figure 76 shows three views of a table, upon which every necessary dimension is indicated. Dimensions extend from arrow point to arrow point. The corner of the table top is cut away to show the detail of the connection between the leg and the rails.

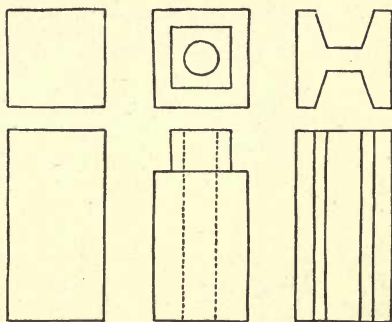


FIG. 75.—TWO-VIEW WORKING DRAWING.

to show the detail of the connection between the leg and the rails. The dotted lines, representing the top view of the rails and the legs, illustrate one method of indicating construction.

41. Sections. — (A.)

In order to show the

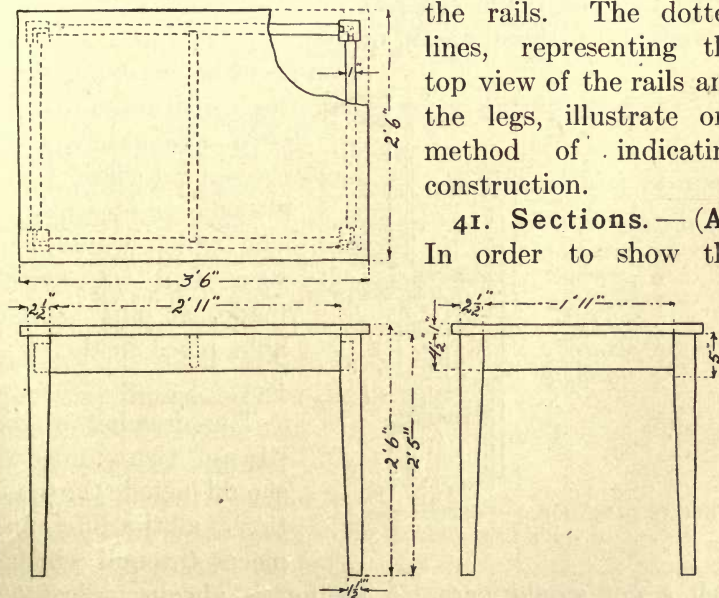


FIG. 76.—THREE VIEWS OF A TABLE.—METHODS OF INDICATING CONSTRUCTION; DIMENSIONING.

construction of details which cannot be indicated upon any of the three views of the object, a drawing of the

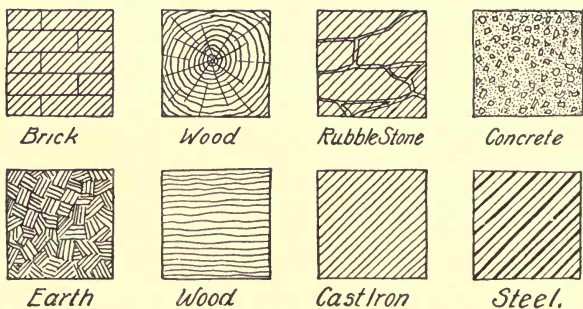


FIG. 77.—CONVENTIONAL SECTIONS.

detail may be made separate from the main drawing, consisting of three views, or more, as required. It is often necessary also, in order that the construction may be shown adequately, to make a sectional view; this is a drawing representing the plane which would be seen if a cut were made at any suitable place in the object.

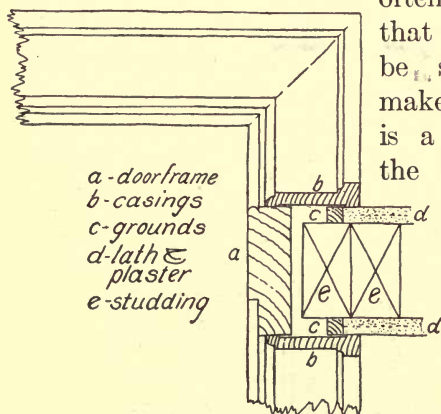


FIG. 78.—SECTION OF CONSTRUCTION—
A DOOR FRAME.

such a cut would pass. A section is always indicated by line or tint shading, the nature of the lines, or the color

The drawing of a plane thus made should include the section of all the different pieces through which

of the shading, suggesting conventionally the material of which the section actually consists, as in Fig. 77, in which is shown the character of the lines generally used to represent the various building materials. If the section is colored, woodwork is illustrated by yellow; iron, by dark gray or black; brickwork, by red; and stonework, by light gray. Section lines running in different directions indicate that different pieces form the section.

Figure 78 shows the horizontal section of a door frame, its finish, and a part of the partition in which the frame is set.

(B.) It frequently happens that a detail may be too large in one or more of its dimensions to be drawn in the desired scale ; in such a case, if the shape of the detail permits it, the entire length may be shown by *breaks* being introduced in places where the part broken out is of the same dimension and detail as at the breaks, as shown in Fig. 79.

42. Center lines. — Figure 80 shows a piece of panel work with breaks, as it is too large to be drawn to the full scale. As both sides of the center line are alike, there is no need of drawing more than one half

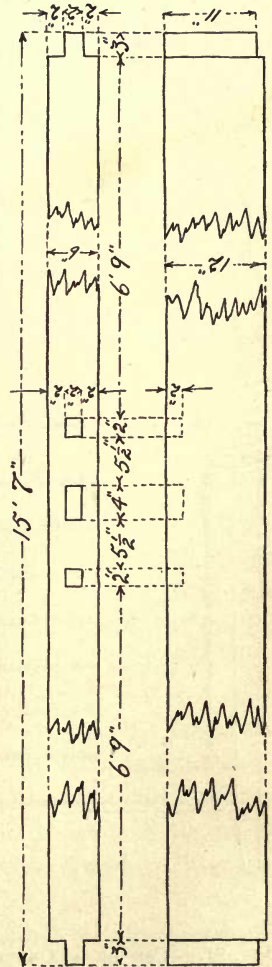


FIG. 79.—METHOD OF
SHOWING A LARGE DETAIL

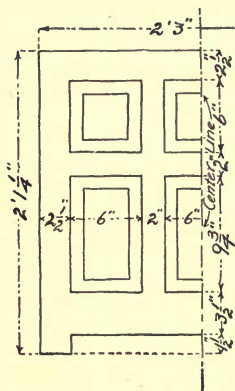


FIG. 80.—USE OF A CENTER LINE.

of it; thus the figure indicates the common method of showing an entire view by drawing one half of it. Notice that the horizontal dimensions are for the entire width, as though the full drawing were shown; therefore but one arrow point is necessary. The center line is often used as indicated in the front and sectional view of the music cabinet, Fig. 81, one half of the outside and the vertical section being shown.

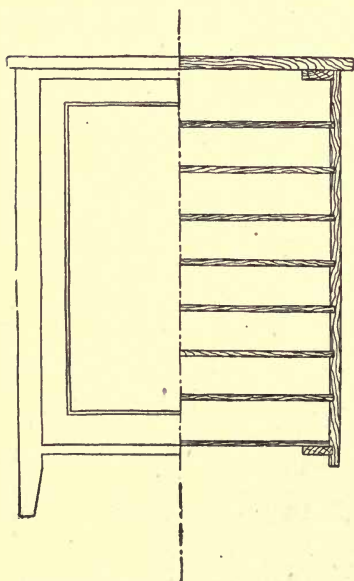


FIG. 81.—USE OF A CENTER LINE TO SHOW OUTSIDE VIEW AND SECTION.

43. Radii and centers.—

Figure 82 shows the method of indicating the radii and centers.

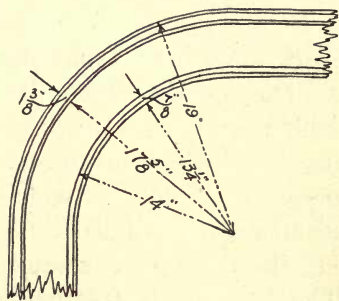
44. Notes and dimensions.—In studying plans, it is important that every reference and explanatory note should be read and carefully considered; every line should be followed its entire length, as what may seem to be of little importance may be the key to a knotty question. In using plans, the workman should invariably follow the figures or dimensions given, and not depend upon scaling, because a mis-

take may have been made in the drawing, or a change made after the drawing was finished. In such cases the draftsman would not change the drawing, but would simply alter the figures, knowing that the workman will follow the figures instead of scaling the drawing. If drawings are properly made, every essential dimension is plainly noted.

Instead of using the words *feet* and *inches*, or their abbreviations, *ft.* and *in.*, it is the usual custom to make the symbol (') for feet and (") for inches; therefore, instead of writing 6 ft. 9½ in., it would generally be expressed, 6' 9½".

45. Using the scale. — In using a scale, the workman must *learn to think in feet and inches*. It is a great temptation to the novice, because it seems the easiest way, to reduce the desired measurements of feet and inches to inches and fractions of an inch. For instance, if in working with a three quarter inch scale, or $\frac{3}{4}" = 1' 0"$, the desired dimension is 6' 8", the easiest way seems to be to reduce it to standard inches, and to say five inches. This is wrong; for, when working with an intricate fraction, or an unusual scale, say, $1" = 1' 0"$, it will be hard to measure or reduce it to a workable fraction if using an ordinary rule.

The 1" and the ½" scales are awkward, as the ordinary rule is divided into sixteenths of an inch, and therefore hard to adapt to measuring twelfths of a foot; thus the



scales most generally used are those which are adaptable to a sixteenth of an inch, for instance, the $\frac{1}{8}''$, $\frac{1}{4}''$, $\frac{3}{4}''$, $1\frac{1}{2}''$, and $3''$ scales.

In a $\frac{1}{8}''$ scale, $\frac{1}{16}'' = 6''$. This scale is adapted only to work upon large buildings, and is the smallest which the average woodworker is likely to use, though on large, general, or assembled drawings of a group of buildings, the $\frac{3}{32}''$ or $\frac{1}{16}''$ scales are sometimes preferred. The $\frac{3}{16}''$ scale is occasionally used, in which $\frac{1}{16}'' = 4''$. The $\frac{1}{4}''$ scale is the usual scale for small and medium-sized buildings in drawing the floor plans and elevations. In this scale, $\frac{1}{16}'' = 3''$. The $\frac{3}{4}''$ scale is frequently used in showing details and sections of construction. These are often placed upon the same sheet of drawings as the smaller drawing that they are to explain, references being made between them either by letters or figures. In this scale, $\frac{1}{16}'' = 1''$.

The $1\frac{1}{2}''$ scale is used for the same purpose as the $\frac{3}{4}''$ scale, and this, or any large scale, may be used for making drawings of furniture and other fittings. In this scale, $\frac{1}{8}'' = 1''$. The $3''$ scale is used for the same purpose as is the $\frac{3}{4}''$ and the $1\frac{1}{2}''$; but, being larger, it allows more accurate drawing and scaling. In this scale, $\frac{1}{4}'' = 1''$. Full-sized drawings are usually made of important details. Figure 83, *A*, shows a part of a $\frac{1}{4}''$ scale, and *B*, a part of a $\frac{3}{4}''$ scale. The distance indicated at *A* is $4' 5''$; and at *B*, it is $2' 9''$. In using a scale to measure an unknown distance from a drawing, — for instance, either of the above spaces, — place the graduation 0 on the line at one side of the space, as at *c*; then move the scale to the nearest smaller graduation of feet at the other extreme of the distance to be measured, as at *d*. In measuring the distance at *A*, move the scale to the right, and at *B*, to the

left, a distance equal to that between d and the smaller graduation of feet; then read the feet and inches as shown upon the scale.

In using an ordinary rule as a scale, the workman will find it more convenient to use the edge which is divided

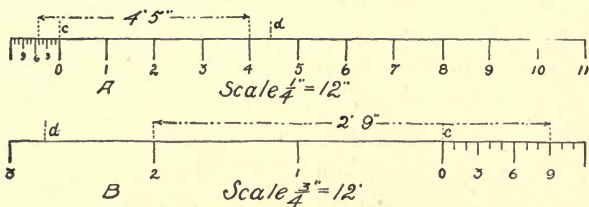


FIG. 83.—USE OF SCALES.

into sixteenths, as indicated in Fig. 84. In using the rule for this purpose, it is tipped upon its edge to bring the graduations nearer the work, and the end of the rule is placed upon the line at one end of the space being measured. The number of feet and inches are then computed, we will

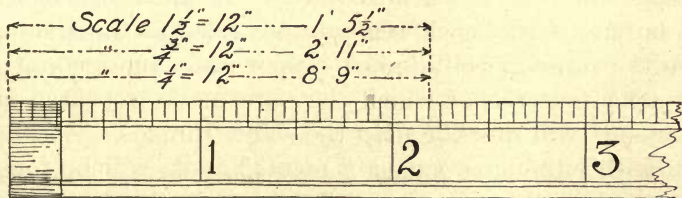


FIG. 84.—USE OF THE RULE IN SCALING.

say to a $\frac{1}{4}''$ scale, the distance $2\frac{3}{16}''$ being reduced to feet and inches by the following mental process: $\frac{1}{4}'' = 1'$; $8 \times \frac{1}{4} = 8'$; $\frac{3}{16}'' = \frac{3}{4}$ of $1' = 9''$; thus we obtain 8' 9". In working with a $\frac{3}{4}''$ scale, by applying the same mental process, we obtain 2' 11". If a $1\frac{1}{2}''$ scale is being used, it will read 1' 5 1/2". The rule commonly used by most

woodworkers is adaptable for scaling by the above method, but a brass-bound rule, which is generally scaled, or some other form of a scaled rule, is preferred by many.

46. Drawing tools. (A.) *The board equipment.*—In making a working drawing, the student should have a *drawing board* (Fig. 85, *a*), a *T square* (*b*), and also a *45° triangle* (*c*), a *30° and 60° triangle* (*d*), and *thumb tacks* (*f*). (See also Figs. 163 and 164.)

Besides the above tools, there should be an architect's *triangular scale*, *pencils*, *erasers*, both hard and soft, and a set of *drawing instruments*, which may be as simple or as elaborate as desired. A medium-priced set, containing the compass with pen and pencil points, divider, ruling pen (if ink work is to be done), and one or more of the spring bow instruments, will be found serviceable and convenient, though the latter instruments may be omitted if desired, as they are necessary only upon small details where accuracy is required. It is false economy to purchase the cheapest set possible, as satisfactory results cannot be obtained by their use; on account of the poor material of which they are made, repeated adjustments will quickly strip the screw threads. A ruling pen with either a wood or a metal handle will be found more serviceable than one of bone, as the latter will break easily.

(B.) In ordinary architectural drawing, and in the drawing connected with this series, by far the larger part of the work will require only the board equipment; therefore, on account of the space required, special instructions in the use of the instruments will be omitted. The writer has observed that the average student will master the use

of the instruments in less time than is required for him to attain a moderate facility in the use of the board equipment.

In using the board tools, the head of the T square should invariably be kept upon the left of the board, as in Fig. 85; it may be moved from top to bottom of the board to allow horizontal, parallel lines to be made at any point upon the paper, as indicated by lines *m m*.

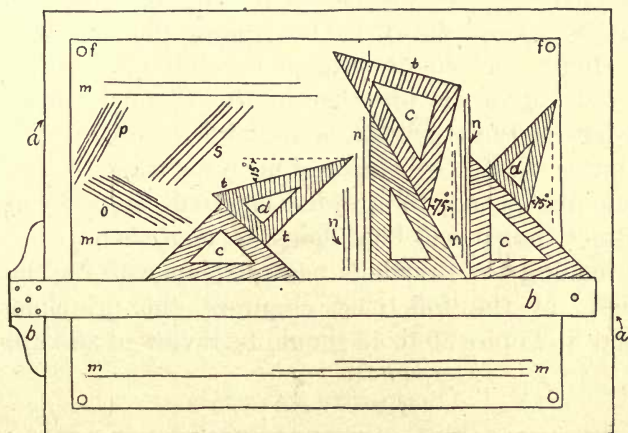


FIG. 85. — DRAWING BOARD, T SQUARE, AND TRIANGLES.

Vertical lines (*n n*), or lines at an angle of 90° with the T square, should be made by the triangles, but if these are not large enough to allow the required line to be made, the T square may be used. Lines at an angle of 30° or 60° with the T square, as at *o* and *p*, should be made by the 30° and 60° triangle, resting upon the T square as indicated. Lines at an angle of 45° should be made by the 45° triangle, as at *s*. The 15° and 75° lines may be made by placing the triangles as shown at *t*; in fact,

any degree divisible by 15 may be drawn by the manipulation of the triangles from the T square in its horizontal position.

To make parallel lines in any part of the paper, which cannot be made by either of the triangles resting upon the T square in its horizontal position, place the T square at any angle that will allow the triangles to rest upon its edge and coincide with the desired angle.

The paper should be placed square with the left end of the board, as shown. The pencils should always be kept sharp, and in drawing horizontal lines should be used only upon the top edge of the T square and upon the edges of the triangles, *not against the edge of the rule*. The latter should be used only for measuring; if used for guiding the pencil, the graduations will soon become so indistinct that it will be difficult to read them.

In making the drawings necessary in working out the exercises of the following chapters, the principles explained in Topics 39 to 43 should be reviewed and applied.

SUGGESTIVE EXERCISES

39. Why is a knowledge of drawing essential to a workman? What is the difference between a photograph, or a perspective sketch, and a working drawing? What is the object of a working drawing?

40. How many views of an object are generally necessary? State exceptions. Describe the mental process by which a draftsman determines the different views of an object.

41. Read and explain a working drawing. Describe sections, and the methods of indicating them. Describe and explain the purpose of breaks in a drawing.

42. What is the purpose of a center line?

43. How are radical dimensions shown?

44. Should the workman scale a dimension which is indicated by figures? How do draftsmen generally change a drawing if it is neces-

sary? How much attention should be paid to explanatory notes upon a drawing?

45. How should a workman think of measurements when scaling? What are the usual scales? Why are not $\frac{1}{2}$ " and 1" scales generally used upon woodwork? What is the scale commonly used upon plans and elevations of medium-sized buildings? What scales are used for details? Mention cases in which full-sized details are made. Describe and demonstrate the process of using the scale. Demonstrate the method employed in using an ordinary rule for scaling.

46. Describe the tools used in mechanical drawing. Demonstrate the use of the different instruments to obtain various results. What tools should be used to guide a pencil in drawing a line? Why not use a rule?

CHAPTER III

CONSTRUCTIVE EXERCISES

47. Object of exercises. — The tool exercises of this chapter are not intended to be performed one after the other, though a certain amount of this work is valuable in forming correct habits in the use of tools before really important work is undertaken. A sufficient number of these exercises should be worked out to familiarize the student with the constructive details of the supplementary models which form the actual course of work. They are also intended to inform the student of the important forms and uses of the different types of joints which are the basis of all construction in wood.

Many of the exercises are shown in *isometric projection*, and are planned to serve only as a basis from which working, or scaled, drawings may be made by each student, before the actual work is begun.

48. Use of exercises. — Before beginning a piece of work, the student should read the text and the references, and should understand every step necessary to complete the model. It will be noticed that the sequence of exercises has been carefully worked out in connection with some of the models which include unusual or difficult features. Where this has been done, the progression should be followed carefully, as otherwise troublesome conditions may develop as the work progresses.

When a tool is used for the first time, the directions for its use should be carefully studied, and correct methods followed from the first.

49. Wood for exercises. — (A.) The following exercises may be made of any soft, easily worked wood. *White pine* is the most desirable in localities where it is not too expensive; *poplar*, or *whitewood*, as it is called in many sections of the country, *bass wood*, and *white walnut*, the latter often known as *butternut*, are also very satisfactory woods for practice.

In general, it is not good practice to cut the pieces to their exact length until after the joint, or one end, has been fitted, as any deviation from absolute accuracy may make it impossible to work to the required dimensions, and the fraction of an inch of wood left for "working," will often save wasting all the material and a great deal of time.

(B.) *General directions.* — All exercises may be glued together after the joint is made, if desired; but it is not necessary, as the pieces may be marked so that they can be laid together as they were fitted.

It is of the utmost importance that neither files, rasps, nor sandpaper be used in making the joints included in the exercises of this chapter, as the student should depend entirely upon his cutting tools in fitting of all kinds. A file, or sandpaper, will invariably destroy a joint instead of improving it.

The face sides of models, which are held together by their construction, should not be smoothed or sandpapered separately, but after they are in their places.

In every case where it is possible, all of the marking, or laying out, should be done for the entire model before a cut is made upon any piece.

EXERCISES

50. Straight edge. Fig. 86.

Material: 1 piece, $24'' \times 1\frac{3}{4}'' \times \frac{1}{4}''$ thick.

A. Lining off: Select a straight-grained, soft $\frac{1}{2}''$ board, and, holding the pencil and rule as shown in Fig. 87, line off the piece about $\frac{1}{4}''$ wider than desired.

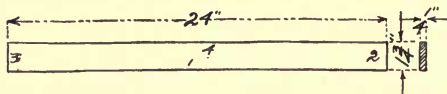


FIG. 86. — STRAIGHT EDGE.

B. Use of the rip saw: Saw to above line. See Topic 11 D.

C. Use of the cutting-off saw: Cut the piece off about $\frac{1}{2}''$ longer than desired.

D. Marking the face side: Mark the figures 1, 2, 3, 4, upon the best, or face, side of the piece, as in Fig. 86, the face edge, or best edge, being marked "1."

E. Planing edge straight: Straighten edge 1. Plane straight and square with face side. See Topics 15 and 19. Use the try-square as in Fig. 5; if desired, the piece may be held in the hand instead of in the vise.

F. Testing an edge: Prove that the edge is straight by sighting along it, and then use a straight-edge to see whether or not the eye is true. All edges should be tested in this way until the eye is trained to know when an edge or surface is true. The use of mechanical aids to accuracy ought not to be encouraged,

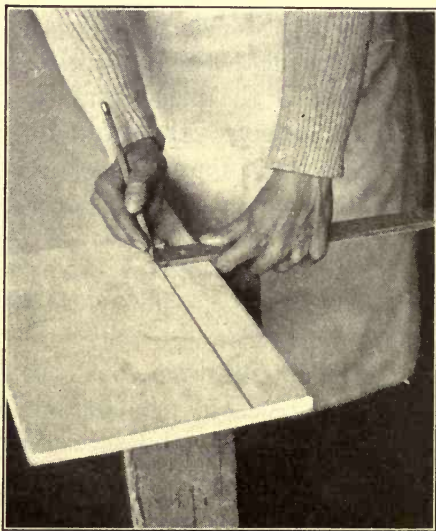


FIG. 87. — LINING OFF FOR RIPSAWING.

as the eye should be trained to perform this work without depending upon artificial means.

G. Square end 2; cut in the bench hook, as in Fig. 88. Use the backsaw, but be careful when the saw cuts through the wood to have it come in contact with the bench hook, and not with the bench.

H. *Block planing*: Block plane end 2. See Topic 18, B, Fig. 34. Make the end square and true, after which it should not be touched again.

I. *Cutting to exact length*: Cut end 3 to neat, or exact, length. Measure from end 2, and mark with a distinct knife cut by the blade of a try-square; do not use a pencil. With a backsaw, cut the end off carefully, leaving the knife mark upon the piece, and with a block plane, work it down to exactly the required length, in the same way that end 2 was finished.

J. *Use of gauge*: Gauge to width. See Topic 7, Fig. 11. Working from edge 1, make a line exactly $1\frac{1}{4}$ " from that edge. Before doing this it will be wise to practice upon a waste piece, until the tool is well under control.

K. *Planing a parallel edge*: With a jack plane, plane edge 4 exactly to the gauge mark, when it should be parallel with edge 1, and square with the face side.

The foregoing is, in general, the method which should be followed in making any piece square.

L. *Planing to thickness*: Using the gauge as above described, make a line upon the edge of the piece entirely around it, and $\frac{1}{4}$ "

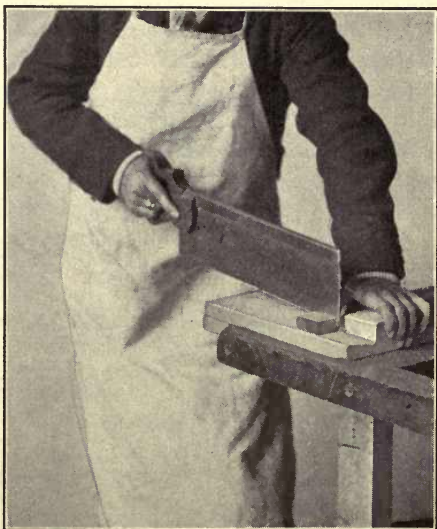


FIG. 88. — USE OF THE BENCH HOOK AND THE BACKSAW.

from the face side. Plane to this line, and, if working against an iron bench dog, guard against bruising the end of the straightedge by placing a waste piece between it and the dog. Do not hold the piece in the vise, as a piece so thin will be sprung out of shape by the pressure.

M. Working from the face side or edge: It is an almost invariable rule in carpentry to work from one side or edge, generally the best, which is known as the face side or edge, and from which everything is worked, measured, or squared. The student should never lose sight of this, and from the very beginning should acquire the habit of working from this edge. This habit becomes second nature to a good workman.

51. Exercise in chiseling. Fig. 89.

Material: Poplar or pine. 1 piece, $12'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

In preparing the material for this and for the following models, the exercises from 50 A to M should be followed with each piece, although

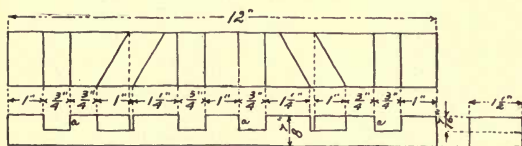


FIG. 89.—EXERCISE IN CHISELING.

if the models are made of $\frac{7}{8}''$ stock, Exercise L may be omitted, because that is a stock thickness, always carried by lumber dealers.

If one end is to be fitted against another piece, as in the various forms of construction, Exercise I should be omitted until after the joint is fitted. See Topic 49 A.

A. Laying out grooves: 1. Mark the grooves with a knife, try-square, and bevel; make the marks upon the face side at angles similar to those shown in Fig. 89.

2. From each of the lines above described, with a knife and try-square, make distinct marks or cuts upon the edge, a little less than one half of the thickness of the piece, measuring by the eye.

3. Gauge very lightly upon both edges, $\frac{7}{16}''$ from the face side between the knife marks (a), thus indicating the sides of the grooves which are to be cut. In using the gauge, be careful not to run over the spaces which will be cut out by the grooves, as the scratches will be a blemish upon the finished work.

B. Cutting grooves: 1. With the backsaw, cut the grooves across the face and by lines *a*, as nearly to the depth gauge marks as possible, without touching them. In doing this, hold the work in the bench hook, as shown in Fig. 88.

2. Cut the grooves by using a sharp paring chisel, somewhat narrower than the width of the groove; remove the wood from between the saw cuts (*a*), as shown in Fig. 89, guarding carefully against cutting

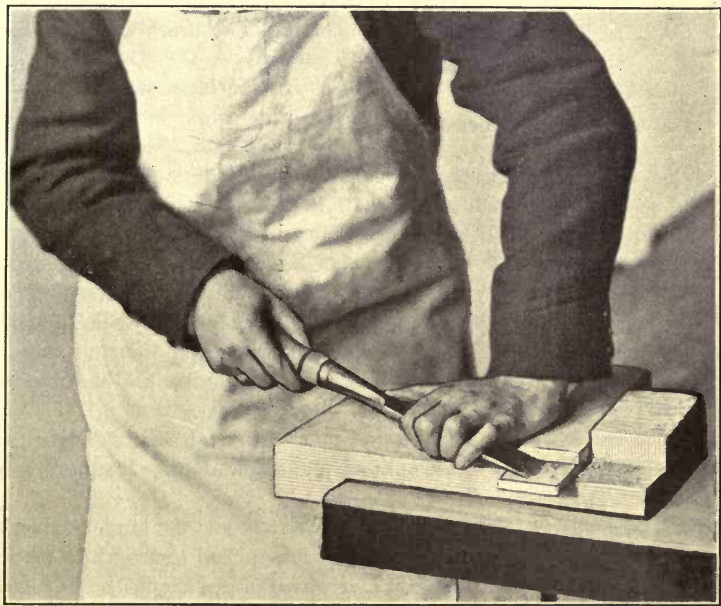


FIG. 90.—USE OF THE BENCH HOOK WITH THE PARING CHISEL.

below the gauge marks upon the edges, or allowing the chisel to follow the grain deeper than is desired. Make light cuts; do not try to take the wood all out at once by using a mallet to force the chisel, but be sure that the chisel is perfectly sharpened, and work slowly and carefully. The best results may be obtained by using the tool as shown in Fig. 90, the beveled side up, as the left hand, holding the chisel, will be an efficient guide and check upon its slipping.

52. Square butt joint. Fig. 91.

Material: 1 piece, a , $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

1 piece, b , $4\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

A. *Fitting the joint*: Preferably holding the work as shown in Fig. 34, saw the joint with the backsaw, and block plane it to a

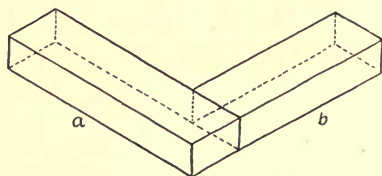


FIG. 91.—SQUARE BUTT JOINT.

perfect fit. Work carefully to a knife mark, and test the work continuously with a try-square to maintain accuracy with both face side and edge.

B. *Marking with a knife*: If accurate work is desired, *never work to a pencil mark*, as it is not

possible to work as closely to a pencil line as to a *distinct cut made with a sharp knife*, which gives a definite line by which the joint may be made. If the work requires that a chisel should be used, as in cutting a shoulder, the knife cut makes a definite line in which the edge of the chisel may be placed. Upon this particular piece of work, however, the chisel will not be used; but the definite knife mark will make possible more accurate sawing, and then all that is necessary to finish the joint is to block plane to the sharp edge indicated by the knife cut.

C. *Cutting to length*: After a and b are fitted at a right angle, cut off the unfinished end of piece b , block plane it, and make it square with the faces.

To repeat and emphasize a previous statement, the student should learn as early as possible in his work to look ahead to see which pieces should be cut to a neat length, and which pieces should be left long to allow for working. The following is a good general rule to apply to all work,—*never cut to a neat length if it can be avoided*. Like nearly every other rule, this will demand judgment in its application, or the endeavor to follow it may result in working to a disadvantage. However, it should always be kept in mind when cutting the stock for a piece of work.

The square butt joint is one of the most common forms of construction, as it is the type of joint used where two pieces are butted together at any angle, as outside and inside finish, plain boxes, etc.

53. End butt joint. Fig. 92.

Material: 2 pieces, $4\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

Fitting the joint: Fit these pieces to each other, end to end, the process of fitting being the same as in the preceding problem.

The work should be done so accurately that, when it is finished, the face edges and the sides of the pieces will form a perfectly straight line with each other. This joint is used where two pieces are butted together, as in lengthening flooring, siding, etc.

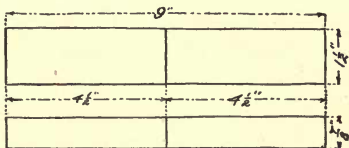


FIG. 92. — END BUTT JOINT.

54. Edge joint. Fig. 93.

Material: 2 pieces, $12'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

Neither piece should be cut to length nor planed to width until the exercise is completed, when it should be treated as one piece.

A. Fitting the edges: Method 1. One edge of each piece should be made perfectly square, by using the jack plane as shown in Fig. 31, and these edges fitted to each other so that the ends will bear a very little harder than the middle, the difference being so slight that the eye cannot detect it. This does not mean that the pieces should be jointed hollowing, as they should be made as nearly perfectly straight as possible.

In doing this work, the plane should be in first-class condition, and the finest possible shaving taken off in finishing the joint. This

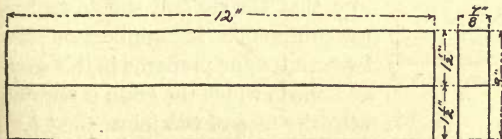


FIG. 93. — EDGE JOINT: METHOD 1.

slight difference in the center of the joint is to allow a certain amount of shrinkage to take place at the ends before the joint will

open, as the ends of a board are more quickly affected by temperature and humidity than is the middle.

B. Reinforced edge joints: This joint is used for table tops and for wide boards, and if reinforcement is necessary, the joint should be matched, tongued, and grooved, or doweled, as in Fig. 94, *a b c*. It is also used on square-edged floors; matched flooring and beaded ceiling are elaborations of the same joint, not entirely for the purpose

of reinforcement, but mainly to allow of blind nailing, as in Fig. 14, and to minimize the effect of shrinking and warping, as the tongue prevents an open joint between adjoining pieces, and keeps the face sides flush with each other. In beaded ceiling, indicated by the dotted line at *h*, the bead hides the joint if shrinking or warping occurs.

C. Gluing the joint: Be sure that the joint is perfectly fitted before the glue is applied, and *do not depend upon the clamps to bring the joint*

together. Any glue joint should be made wood to wood, or the glue is worthless, and if the joint does not fit perfectly, it will always be weak and apt to give way when shrinking or swelling takes place, or from a sudden blow. (See *H* below.)

A wide miter joint may be tongued and grooved as at *d*, Fig. 94. In a case of this sort, the length of the tongue, or its grain, is at right angles with the face of the joint, so as to give all the strength possible to resist the tendency of the joint to open. The joint may be held in place by handscrews until the glue sets, as described in Topic 70. It is important that the student should realize the difference in application between a tongue prepared in this way, and one in which the grain is parallel with the face of the joint, as at *b*.

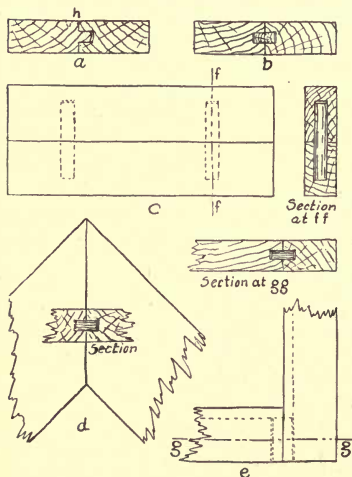


FIG. 94. — JOINTS.

a, Matched joint; *b*, tongued and grooved joint; *c*, doweled joint; *d*, tongued and grooved mitered joint; *e*, tongued and grooved panel work.

A cheap grade of panel work is sometimes made by the use of a tongue as shown at *e*, Fig. 94.

D. Jointing wide boards: In general, the face side of the work should at all times be kept toward the workman, and especially is this true in making a glue joint. The joint should be made so that the faces of adjacent boards will be as nearly as possible in line with each other. This will be difficult if the boards are warped or twisted, though the worst of them may be ripped through the middle, and the inaccuracies of one piece used to compensate those of the boards against

which it is fitted. This requires more work, but if a poor grade of stock is being used, a much better job may be done.

E. Fitting the edge joint: Method 2. Some workmen joint the edges of the two members of a joint at the same time, as in Fig. 95. It requires skill to do this well, and it is necessary that the plane iron should be nearly straight on the edge, and carefully sharpened and adjusted. By this method, if the face sides are opposite each other while the joint is being made, as indicated, and if the work is accurately done, the joint will be a perfect fit when the pieces are brought into their proper relation.

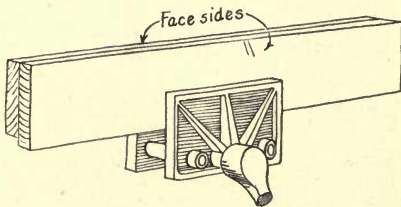


FIG. 95.—JOINTING TWO PIECES AT ONCE: METHOD 2.

F. Fitting the edge joint: Method 3. In making a glue joint less than four feet long, many workmen do not fit the edges by means of a try-

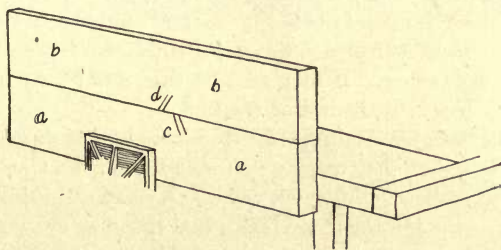


FIG. 96.—THE "TRY" METHOD: METHOD 3.

square, as it may be done more economically by the "try" method, if the workman has sufficient skill.

1. Mark the face corners as at *c, d*, of pieces *a, b*, Fig. 96, which is the usual face mark, and is so understood by other workmen. (This mark will hereafter be used to designate the face side and edge where necessary.)

2. Joint the edge of piece *a* by simply planing it straight, not using the try-square, but depending upon the "feel" of the wrist to make the

edge approximately square. (The student may use the try-square until he has acquired the "feel.")

3. Remove piece *a* from the vise, turn it "end for end," or reverse the ends, and lay it upon the bench with the face corner, *c*, in position,

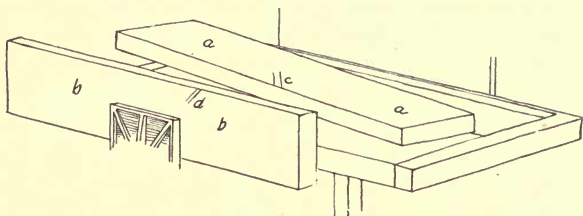


FIG. 97. — POSITION OF THE PIECES OF THE JOINT IN FITTING THE SECOND PIECE.

as shown in Fig. 97. Place piece *b* in the vise, with the face corner, *d*, up, and toward the workman, as indicated.

4. Joint the edge approximately straight, and square by the same method used in jointing piece *a*.

5. Place piece *a* upon *b*, as in Fig. 96, and apply the try-square as in Fig. 98, to see whether or not the faces of the two boards are straight or fair with each other. If they are not, edge *d* of *b* may be jointed to bring both pieces in their desired relation.

6. Unless both pieces are perfectly fair and "out of wind" (*i* as in kind), that is, unless they will lay perfectly flat upon a true surface, it is impossible to make a joint which will stand this test of the try-square; and by this method, if the boards are a little winding or twisted, as they are very apt to be, they may be averaged to make the finished board more nearly true than would be practicable if its accuracy depended upon a try-square.

7. In testing the two members of a joint for accuracy, place their edges together with nothing to hold them, as shown in Fig. 99, and move piece *a* back and forth a little, sideways; if there is a lump upon either edge, *a* will swing upon it as upon a pivot, as at *k*. The same test should be applied from each end, and the defect carefully remedied.

8. To obtain the best results in gluing up a wide board, the center of the joint should be a very little open, as explained in *A* of

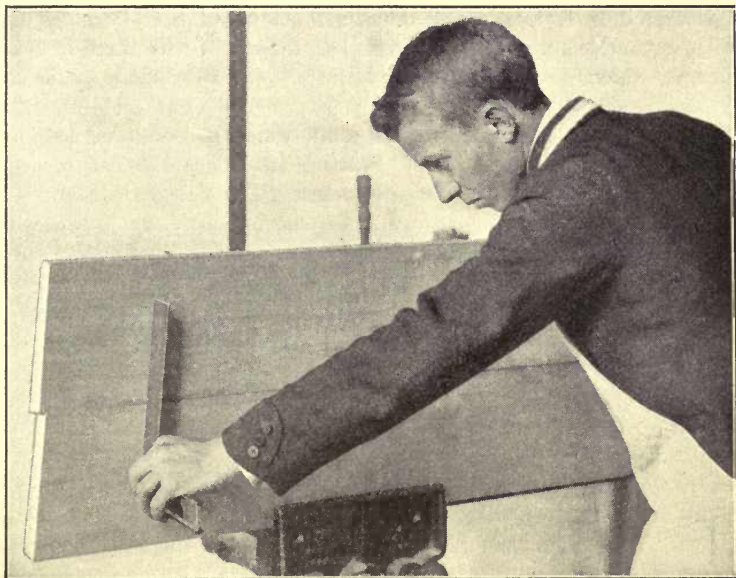


FIG. 98.—TESTING THE FACES OF THE PIECES.

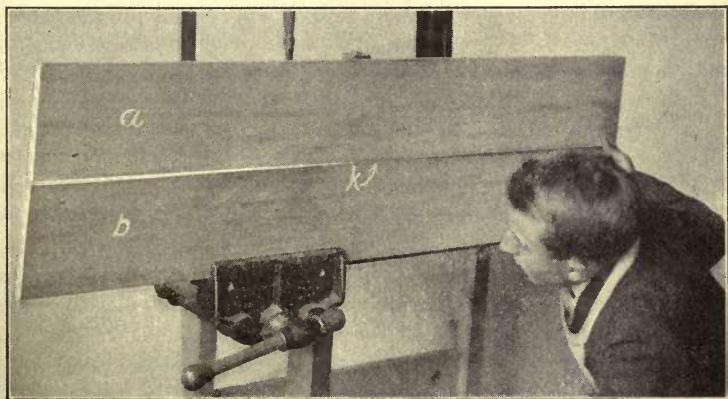


FIG. 99.—TESTING THE JOINT.

this exercise. If this is well done, a short board may be glued up with but one clamp to hold it together, instead of with three or four clamps, which would be necessary if the joint were made perfectly straight.

G. Rub joint: Method 4. This joint, which is sometimes used in gluing up wide boards, is made by fitting two edges together, so that they will bear equally their entire length. The glue is then put on and the pieces rubbed back and forth endways until the glue is well rubbed out of the side of the joint or into the wood. In doing this, care should be taken that the sides of the boards are kept flush; therefore this form of joint can be used only with perfectly straight stock. After the joint is made, the board should be set away until the glue is thoroughly hardened, until which time the board should be handled very carefully, as a sudden jar or blow may break the joint. If well made, this joint is as strong as any unreinforced square-edged joint.

H. Gluing: In all glue joints, except the rub joint, the pieces should be fitted and held wood to wood with clamps, or hand screws, until the glue sets. The glue should all be squeezed out, as there is very little strength in a joint which shows a fine line of glue.

To repeat and emphasize *B*, it is the glue which enters the pores of the wood of each member of the joint that gives the joint its strength, and if the joint is not perfectly fitted, a quick rap or exposure to a sudden change in temperature is liable to break it open.

I. Preparation for smoothing: After the glue is set, which will take at least three hours for hot glue, or twelve hours for cold glue, the superfluous glue upon the surface of the board should be cleaned off, and the board trimmed to the required size when it is ready for smoothing. For smoothing a surface, see Topic 17.

J. Sandpapering: In making ready for the sandpaper, do not depend upon the sandpaper to make the work smooth, as it is easy to scour a hole in the surface. Although this may seem of no importance, when the finish is spread, it may be very prominent, and will always stand as an evidence of unskillful work. The smoothing plane and the scraper are the tools which should do this part of the work. For the use of the latter tool, see Topics 29 and 30.

In using sandpaper, a sheet should usually be torn in halves the short way of the paper; if it is to be used upon a flat surface, one half should

be folded back to back, and held, not tacked, around a block about $3'' \times 4'' \times \frac{7}{8}''$ with the hand, as in Fig. 100.

The act of grasping the block with sufficient force to hold it while at work will keep the sandpaper in its place. The use of any device to fasten it there is an unmistakable mark of the novice, as the workman realizes that his time is too valuable to spend upon anything so useless as tacking a piece of sandpaper to a block or using any of the devices

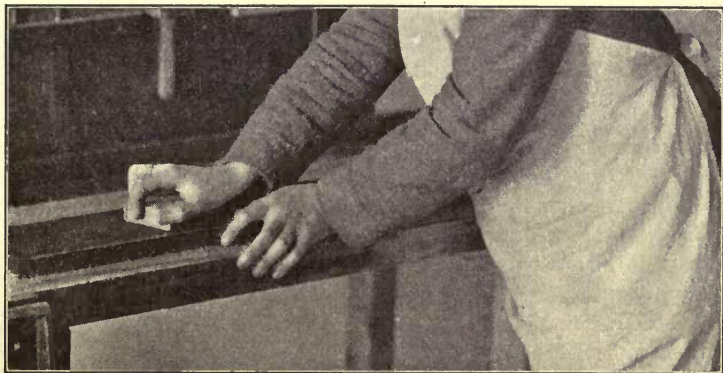


FIG. 100. — METHOD OF GRASPING SANDPAPER.

that some amateurs consider an advantage. A sandpaper block should always be used upon a flat surface, and the smaller the surface, the more need there is of a block.

If there is much sanding of moldings to be done, it is best to make blocks to fit their curves, as it is hard upon the hands to do this work very long at a time, though nothing has ever been devised which fits irregular forms as well as the fingers. *Never use sandpaper upon a piece of wood until all of the cutting upon it with edge tools has been done*, as the particles of sand will enter the grain, and any edge tools used upon it afterwards will be dulled quickly.

1. In using sandpaper, the workman should guard against rounding square corners or destroying the form of curved or flat surfaces, a raw corner, however, should always be removed with a few light, careful strokes, as otherwise, if it is square, it will be more or less ragged. When this is well done, it is one of the evidences of skillful workmanship.

2. Do not use a piece of sandpaper so large as to prevent any part of it from being under perfect control, for the loose ends will scratch the wood, and it has an awkward and unworkmanlike appearance.

3. Always work parallel with the grain, and be sure that all plane marks and uneven places are well rubbed down. In order to do this, it is often necessary to use considerable muscle. This part of the work requires good judgment, for unless sandpapered thoroughly, there are apt to be places which will show when the finish is spread on the work, though they may have been invisible before. No one can tell as well as the workman himself when he has sandpapered enough, though it may be evident to any one if it has been done injudiciously, and one or two careless strokes may destroy an otherwise good job.

Upon a coarse job it is usually allowable, and sometimes desirable, to sandpaper across the grain, especially if the work is to be painted.

Too much care cannot be taken in the use of sandpaper, especially upon the part of the amateur, for he is more liable to injure his work than to improve it.

55. Intersection joint. Fig. 101.

Material: 1 piece, *a*, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

1 piece, *b*, $6'' \times 2\frac{1}{2}'' \times \frac{7}{8}''$.

1. *Fitting the joint:* Lay the pieces upon each other, as indicated by the dotted lines, at the angle of their intersection, and mark point *c*

upon both pieces. Never measure with a rule in a case of this sort, if it is possible to measure with the piece of wood itself.

2. Connect points *c* and *d* across the face of each piece by a distinct knife mark, which will give the cut. With a try-square and knife, transfer the angle to the other side of each piece.

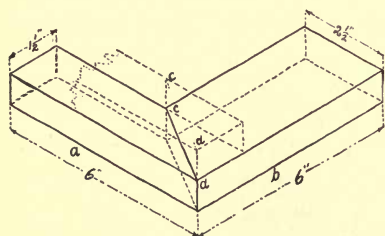


FIG. 101. — INTERSECTION JOINT.

3. Cut carefully to the mark with the backsaw, leaving the mark upon the piece wanted.

4. Block plane the pieces to form a perfect joint at the angle desired.

5. Cut pieces to the desired length.

6. Fasten the pieces together by a rub joint.

7. Smooth and sandpaper after the glue has set.

This joint is used where it is desired to joint pieces of different widths together without allowing end wood to show. The same method may be used when two pieces of the same or different widths join at any angle.

56. Lap joint. Fig. 102.

Material: 2 pieces $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

1. *Fitting the joint:* Plane the two sides which are to be glued together, and sandpaper them; do the same to the end of each piece which is adjacent to the joint, as at *a a*.

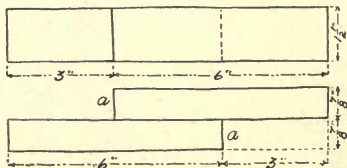


FIG. 102. — LAP JOINT.

2. Fasten the pieces together with glue or brads, or both; if the glue is used, apply *sparingly*, or it will squeeze out at the ends, and make unnecessary work in cleaning it off. Hold the joint closely together with a hand screw until the glue sets; see Fig. 63 and Topic 33 B.

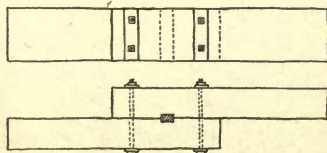


FIG. 103. — LAP JOINT, KEYED AND BOLTED.

3. After the glue is set, work the model to the desired dimensions; smooth and sandpaper.

The form of the joint shown is one of the simplest and most common in use. It may be seen wherever two pieces lap over one another. Upon heavy work, the joint is often keyed with one or more keys and bound

round with strap iron, or bolted through plates, as shown in Fig. 103.

57. Fished joint. Fig. 104.

Material: 2 pieces, *a*, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

2 pieces, *b*, $6'' \times 1\frac{1}{2}'' \times \frac{1}{4}''$.

Prepare the pieces by jointing one edge of each and making pieces *b* of the desired length. Do not work either *a* or *b* to width.

1. *Fitting the joint:* Fit pieces *a* as in Fig. 92.

2. Smooth and sandpaper both sides of pieces *a*, keeping them both of the same thickness.

3. Sandpaper ends of pieces *b*.

4. Fasten together with either glue or brads, or both, keeping planed edges flush, and ends of pieces *b* opposite each other.

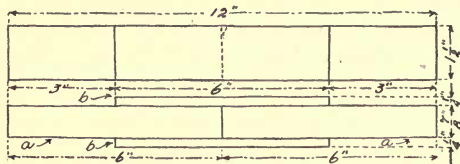


FIG. 104.—FISHED JOINT.

unsightly joint. The form shown is used in piecing out studding and in other places which are out of sight. If the work is judiciously done, it will be as strong as the material from which it is made. This type of joint is often used upon heavy construction, in which case it is keyed and strapped in order to secure the greatest strength and rigidity.

58. Mitered joint. Fig. 105.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

A. Uses of the mitered joint: The term *miter* is usually applied to the angle of 45° , by which a right angle is joined together, but any angle may have its miter. It is one of the most common joints, and is used in making picture frames, and in fitting door and window casings, base moldings, etc. It takes the place of the square butt joint upon plain wood in many places where it would be objectionable for the end wood to show. The intersection joint is an adaptation of this joint.

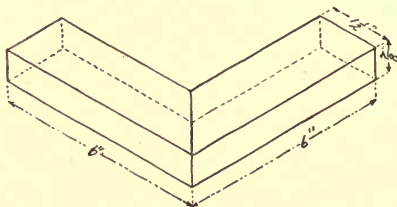


FIG. 105.—MITERED JOINT.

B. The miter box: In cutting a miter, it is customary to use a miter box. The form of miter box shown in Fig. 106 is one of a number of patented, adjustable, iron miter boxes upon the market, one of which is usually owned by every carpenter who works upon the bench or inside finishing. (In purchasing a tool of this sort, the longest saw possible should be selected.)

1. Place the molding in the box, as indicated.

2. After the ends of the pieces which form the joint are sawed, fit them together with a block plane. If the pieces are for outside work,

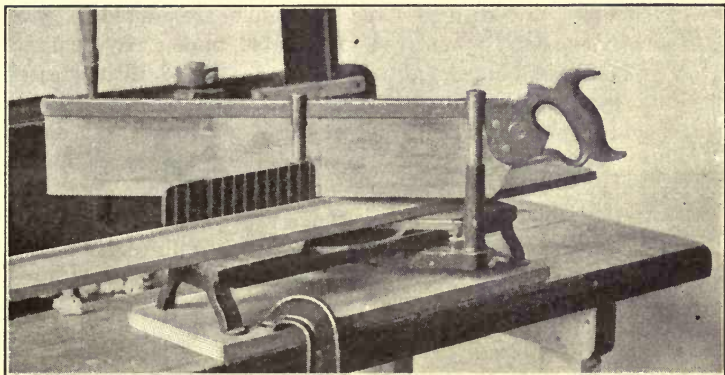


FIG. 106.—IRON MITER BOX WITH PIECE IN PLACE READY FOR SAWING.

an accurate saw cut is generally sufficient, but if the saw has not made the miter a good fit, or if the mitered angle is not exactly true, the block plane must be used.

C. Nailing a mitered joint: In nailing a mitered joint (as in a picture frame), bore holes for the nails in pieces *c*, and place *b* in the

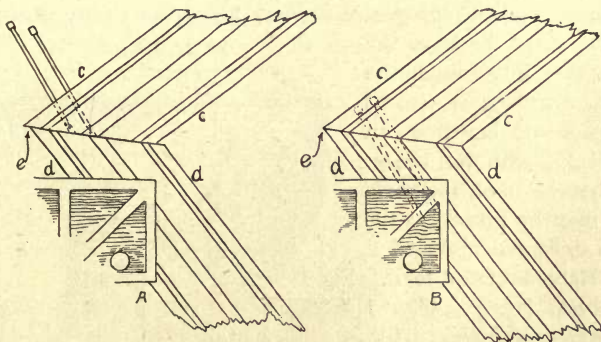


FIG. 107.—A. METHOD OF HOLDING MITERED JOINT FOR NAILING.
B. MITERED JOINT NAILED, MEMBERS INTERSECTING.

vise as indicated. The pieces should be held as shown in Fig. 107, A, piece *c* projecting beyond piece *d* about $\frac{1}{8}$ ", as at *e*, so that when the nails are driven home they will force the members of the moldings to coincide, as at *e* in Fig. 107 B.

Glue should always be used if the best results are desired.

After the nails have been driven as indicated, piece *c* may be placed in the vise, and holes bored and nails driven through *d*, if the greatest strength is desired; this is not advisable upon ordinary work, however, and should be done only upon large moldings, on account of the danger

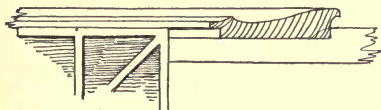


FIG. 108. — METHOD OF HOLDING FINISHED MOLDING IN A VISE.

of splitting the wood, and of nailing the joint open unless the nails are driven very skillfully, since they pull against each other.

Notice that the nails are pointed a very little outside of

square with the edge of piece *c*. A little practice will convince the workman that driving nails at about this angle will give better results than if the nails are driven square, or at a greater angle, as the tendency to slide, or drive open, is thereby lessened.

A wooden miter box is preferred by many workmen in finishing down the outside of a house. (See Topic 71.)

D. Marking a miter with the bevel: If it is desired, the student may, in this exercise, lay out the angle of the miter by using a bevel for the face, and the try-square to mark across the edge; or, in place of the bevel, he may use the miter square, a tool made the same as a try-square, except that the blade is set at an angle of 45° with the beam. If the bevel is used, the angle of 45° may be found by the method indicated in Fig. 9.

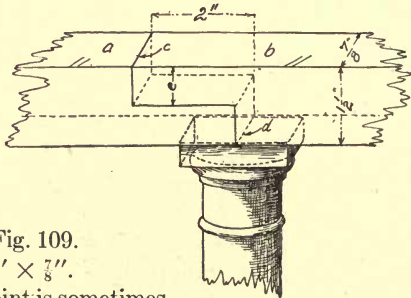


FIG. 109. — HALVED SCARFED JOINT.

59. Halved scarfed joint. Fig. 109.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

A. Fitting the joint: This joint is sometimes used when it is necessary to join two timbers lengthwise. If used as a girder, there should be a support under the joint at *d*. This form of construction is sometimes fastened together by the same methods as shown in Fig. 103.

1. Lay off the shoulders of the joint, say $2''$, by a distinct knife

mark upon the face, or top edge, of piece *a*, at *c*, and upon the back, or bottom side, of piece *b*, at *d*.

2. Square from these marks, with a knife, a little less than half of the thickness of the piece upon each edge.

3. Set the gauge to the distance *e*, which should equal half of the thickness of each piece, and mark plainly from the face side upon the two edges and across the end of each piece.

B. Cutting to a knife mark with a saw: With a backsaw, cut to the gauge mark from the face of *a* and the back of *b*. Place the pieces one at a time in the vise, and with the backsaw cut out the recess between *c* and *d*, and their respective ends, which will allow the pieces to come together. If this is done with sufficient accuracy, the faces will fit and be flush (even). *The saw cut should be made with such*

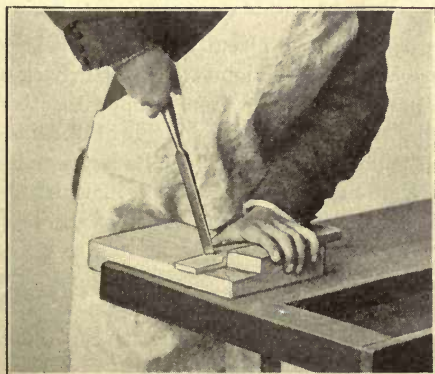


FIG. 111. — INCORRECT USE OF THE CHISEL IN FITTING A SHOULDER.

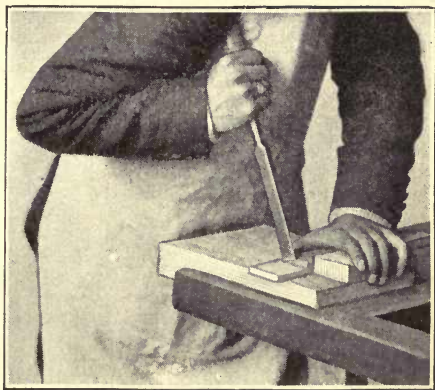


FIG. 110. — CORRECT USE OF THE CHISEL IN FITTING A SHOULDER.

accuracy, that one half of the knife and gauge marks will be left upon each of the two pieces that are to form the joint, in which case, all that will be necessary to make a perfect fit will be to trim the joint a very little with a sharp chisel.

C. Fitting with a chisel: If any fitting of the shoulder is necessary, *do not do it by guesswork, but make a distinct and accurate knife mark at the*

exact place required to make a perfect fit. In trimming to this mark, grasp the chisel as shown in Fig. 110, not as in Fig. 111, which is extremely awkward and inefficient. If the chisel is used as in Fig. 110,

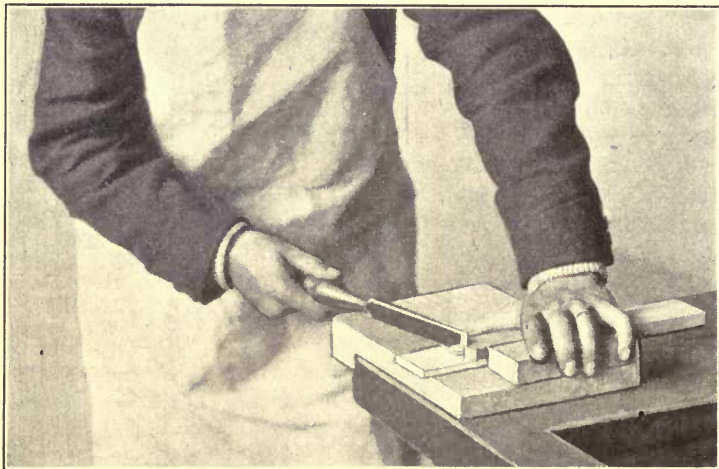


FIG. 112.—INCORRECT USE OF THE CHISEL IN FOLLOWING A LINE.

very little strength is necessary, as the pressure of the shoulder does the cutting.

In fitting a joint of this sort, it is best to "cut under"; that is, to cut the wood inside of the visible part of the joint a very little back of the line, so that nothing will prevent the joint from coming together.

Never try to follow a line by using the chisel as in Fig. 112, as the chisel is apt to run into the shoulder beyond the line, its bevel giving it a tendency to "lead" back of the knife mark which indicates the shoulder, thus destroying the joint. The visible portion of any joint should be as nearly perfect as possible; therefore in this case, the longitudinal portion should be perfectly straight, or slightly hollowing.

Glue the pieces together, using hand screws to hold them in place each way. Cut the model to desired length, and smooth and sand-paper.

60. Tapered scarfed joint. Fig. 113.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

This form of scarfed joint is used for the same purpose as that described in Topic 59, but it has a greater shearing resistance, or a greater resistance to pressure from above. It is obvious that the pieces must be securely bolted, keyed, or strapped, unless the ends are secured so that there cannot possibly be any slipping endways.

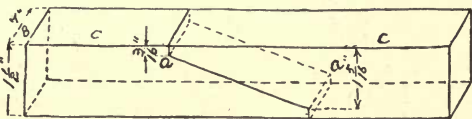


FIG. 113.—TAPERED SCARFED JOINT.

Fitting the joint: In laying out this joint, use a knife and try-square; the distance from the face edge at a should be $1\frac{3}{16}''$, and that at the other end of the cut should be $1\frac{5}{16}''$. This latter mark should be made only from $1\frac{5}{16}''$ from the face corner, indicated by c , to the lower edge of each piece, since, if a knife mark were made across the side, it would remain a blemish upon the finished model, as it is difficult to smooth out a knife mark. These marks, which indicate the lines $a a$, should be made upon both sides of each piece. With a gauge, working from the face edge, which is marked with the face marks, c , lay off the distances $1\frac{3}{16}''$ and $1\frac{5}{16}''$ by points, not by scratches, as the latter might make a blemish. Join these points with a knife mark; cut and fit as in Topic 59. Fasten together and finish, as in the preceding exercise.

61. Notched, or locked, joint. Fig. 114.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

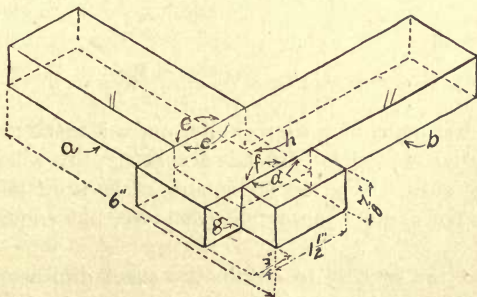


FIG. 114.—NOTCHED, OR LOCKED, JOINT.

A. Laying out the joint: This joint is often used at corners, where a cheap and strong joint is required.

In this and the following exercises, *be sure that every cut is laid out correctly before any cutting begins.*

1. In making this joint, lay off with a distinct knife mark by a try-square, as in Fig. 6, the distance of the lock end, say $\frac{3}{4}$ ", upon the face side of piece *a* and upon the back side of piece *b*.

2. It is important that *the size of the cut should not be measured from these cuts by a rule, but by the pieces themselves.*

As the face sides of pieces *a* and *b* should be flush when the model is finished, it is plain that the width of piece *b* on its face side at the joint must be cut out of the face side of piece *a*; likewise, the width of the back side of piece *a* must be cut out of the back side of piece *b*.

3. Hence, turn piece *b* over so that the edge *c* of its face side will rest exactly over the knife mark *d* of piece *a* of Fig. 115.

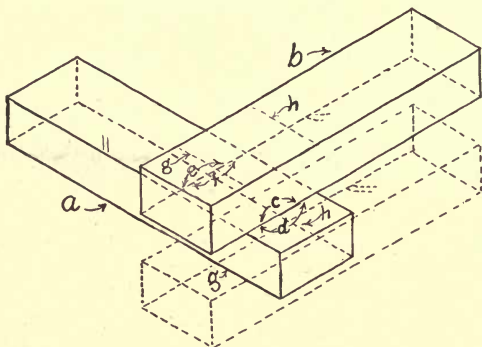


FIG. 115.—LAYING OUT THE CUTS OF THE NOTCHED, OR LOCKED, JOINT.

4. With the point of a sharp knife, make a mark at *e* on piece *a* close to the edge of piece *b*. If made accurately, this will give the exact width of the cut. Using the try-square, make a distinct knife mark a little inside of *e*, not a measurable distance, but enough to insure a close fit.

5. Repeat the process to obtain the exact dimensions of the cut upon the back side of *b*, laying the pieces back to back instead of face to face.

6. From these knife marks, proceed as in 51, A, 2.

7. See 51, A, 3.

8. If the joint is too close, remedy it by using the chisel as shown in Fig. 110.

Before the joint is glued together, sandpaper the edges of the pieces; be careful not to touch the joint, however, as this may easily be made too small.

B. Smoothing surfaces which join at an angle: After the joint is fitted, the pieces glued together, and the glue set, smooth the face and back sides with a smoothing plane, being careful that the plane is in the best possible condition; also be sure that no cut is made directly across the grain; otherwise, a piece is apt to be chipped off. Plane with the grain if possible, but if it is necessary to plane across the joint, do so at an angle of about 45° , and use care that the plane cuts in the direction of the grain most favorable for smooth work.

If the lock end is left off, we have a halved joint, sometimes erroneously called a lap joint, which is used in the construction of frame buildings in fastening the plates and sills at the corners, as in Fig. 99. The lock joint should be fitted so closely that glue is unnecessary, but it may be glued together if desired.

62. Housed, or tank, joints. Fig. 116.

Material: 3 pieces, $4'' \times 3'' \times \frac{7}{8}''$.

These joints are used in making waterproof tanks and sinks.

Fitting the joint: At *a* is shown the form of joint generally used upon work which will allow sufficient wood beyond the groove, as at *c*, to give strength; it is somewhat cheaper to make than the joint at *b*, which is commonly used for light tanks and sinks, as it may be made more nearly water-tight than the other form.

1. Smooth the piece which is to connect the two ends.

2. Mark with a try-square and knife the side cuts of the groove of end *a*, by adaptation of the method described in Exercise 61.

3. Mark the end of the tenon of *b* with a gauge, and lay out the shoulder with a knife.

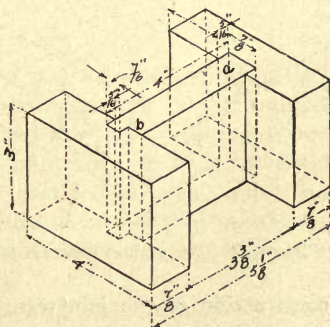


FIG. 116. — HOUSED, OR TANK, JOINT.

This joint is used in fitting floor timbers to sills, girders, and plates, and is a very common one in building construction. Floor timbers are sometimes mortised into the sills and girts, but this is not generally done upon ordinary work.

The size of the joint is regulated by the width of the timber, as it is measured from the upper edge, the distance from *a* to *b* being the same upon all timbers of the same floor, so that the top edges of the floor timbers will be in line, and the floor will be straight. In practice, the vertical height of the shoulder *c* is not considered, but the distance between the shoulders of each end is sometimes important, as it may be used to govern the distance between the walls.

1. Gauge the distance *a b* from the top edge.

2. Measure from the end of piece *d*, the thickness of piece *e* for the shoulder *c*; mark with the knife, and cut out with the backsaw. Upon ordinary work this joint is marked with a pencil.

The piece *d*, representing the floor joint in this exercise, may be fastened to piece *e*, or the sill, by a brad; or it may be glued, if preferred. Smooth and sandpaper each piece separately.

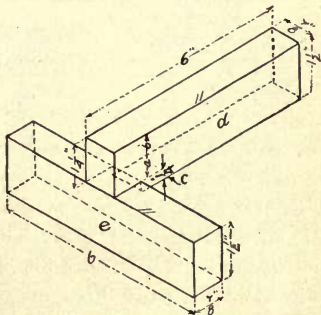


FIG. 118. — CHECKED JOINT.

65. Mortised joint. Fig. 119.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

This is a common form of joint, and may be made at any angle.

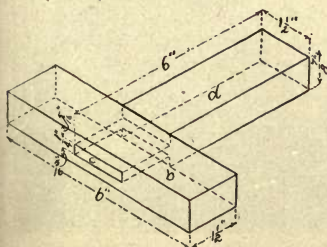


FIG. 119. — MORTISED JOINT.

It is used in framing girts into corner posts and the ends of braces, in the manufacture of doors, panel-work, and in nearly every place where two pieces are to be fastened together at any angle, and the greatest strength is desired.

A. Laying out the joint: 1. Lay out with a knife the length of the tenon upon *d*, which should equal the width of the mortise member, *b*.

2. Lay out the length of the mortise upon each edge of the mortise member, *b*, in the middle of the piece, lengthways; to insure a

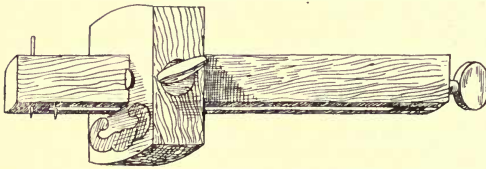


FIG. 120. — MORTISE GAUGE.

close fit, this mortise should be a little less than the width of the tenon in length. If made too small, a light cut will remedy it. These two marks should be made with

a sharp pencil, since in transferring the lines with a knife across the face of piece *b*, a knife will make a scratch that will be difficult to remove.

3. *Use of the mortise gauge:* Gauge for the mortise in piece *b*, and the tenon on the end of *d*. Set the mortise gauge, Fig. 120, and mark both pieces at once without changing its set. It is economy to use this tool where two lines are to be made at once, as it saves handling each piece over twice, and the marks may be made more accurately than if the ordinary gauge is used. This tool is used the same as a single-point gauge, the head being set in the right relation to the outside point (in this case, $\frac{9}{16}$ "), the screw at the other end of the stick being manipulated to bring the inside point to its correct distance between the outer point and the head (in this case, $\frac{1}{4}$ " from the former, which is the important measurement). Tighten the thumbscrew in the head to hold it in the desired position.

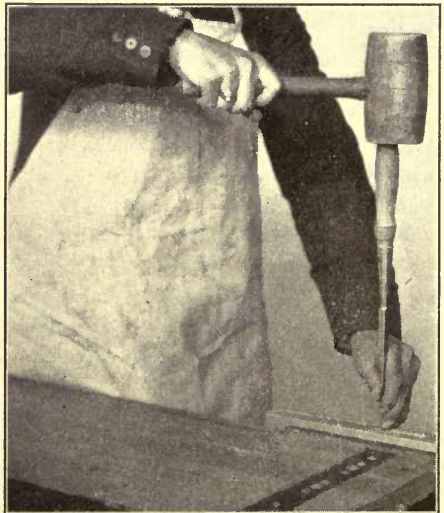


FIG. 121. — METHOD OF GRASPING A CHISEL FOR MORTISING SMALL WORK.

Always working from the face side, mark around the two edges and the end of the tenon and the mortise, on both edges, using care not to make a scratch beyond the mortise or the tenon, as it will not work out.

B. Cutting the joint: Bore a $\frac{1}{4}$ " hole in the middle of the mortise from each side, halfway through. If bored from one side, it would probably not come through

accurately. In a large mortise, or in hard wood, the mortise may be bored nearly out by boring several holes. In cutting out a small mortise with a narrow chisel, work from the hole in the center to each end of the mortise, holding the chisel at right angles with the grain of the wood, as shown in Fig. 121. In this way it may be guided more accurately at the beginning of the cut than if held as in Fig. 122, which is the usual method of grasping a chisel for heavy work. After starting a chisel



FIG. 122. — METHOD OF GRASPING THE CHISEL FOR MORTISING LARGE WORK.

accurately in a small mortise, the hand will naturally slip up toward the handle. The back of the chisel, *c*, should be kept toward the end of the mortise toward which the student is working. Under no conditions should chisel cuts be made parallel with the grain until after the wood in the center of the mortise has all been cut out, as the wood at the side may be split. The tenon should be made by cutting out the wood on each side of it with a back-saw, and, if necessary, trimming with a chisel, as described in Topics 59 *B* and *C*.

C. Drawboring: Figure 123 *A* shows a mortised and tenon joint, drawbored; the tenon shoulder, *a*, is less distant from the hole, *c*,

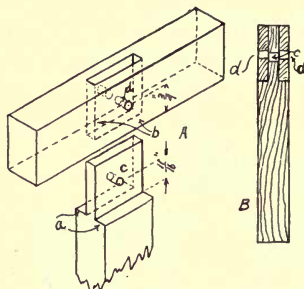


FIG. 123. — MORTISED JOINT, DRAWBORED.

in the tenon than the mortised shoulder, *b*, is from the hole, *d*, which pierces the wood on each side of the mortise. When the tenon is pushed into the mortise, and a pin driven through the hole, it is obvious that the joint will be drawn to a perfect fit, if the work has been well done. This joint is frequently used in the construction of buildings, for additional strength, and where it is necessary to hold the joint together while other parts of the work are being fitted. It is also used in the manufacture of sash and machinery frames, and in furniture to some extent. A section of this joint is shown at *B*.

66. Mortised joint and relish. Fig. 124.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

This joint is used in joining the stiles and bottom rails of doors, panelwork, etc. If the mortise extended to the bottom of the stile, to allow the tenon to be the full width of the rail, it is plain that it would be a weak joint, therefore the relish is cut out of the rail. This joint is made by the same methods as those above described. Hold together by pin, if necessary, but do not use glue.

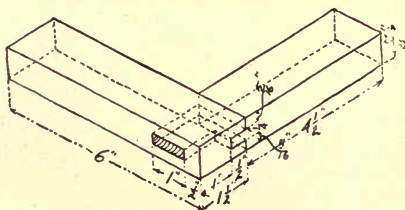


FIG. 124. — MORTISED JOINT WITH RELISH.

67. Dovetailed brace, or halved, joint. Fig. 125.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

This joint is sometimes used to fasten braces into corner posts, girts, and sills, where they will be subjected to both tensile and compressive strains. A very strong joint may be made in this way, though piece *b* is weakened 50 per cent on account of the wood being cut away for the dovetail, and piece *a* still more.

1. *Fitting the joint:* Set the bevel to the required angle for the shoulder, *c*, which is the angle of intersection, and cut the end of piece *a* at the same angle.

2. On the back of *a*, at a distance equal to the width of *b*, measure the distance *d*, or the width of piece *b*, square with the end; make a distinct knife mark by the bevel, which indicates the shoulder *c*.

3. Without changing the angle of the bevel, make a pencil mark across the face of *b*, at the place at which pieces *a* and *b* intersect.

4. With a gauge set one half of the thickness of the pieces, mark the thickness of the dovetail on piece *a*, and of the slot which is to receive it, in piece *b*, working from the face side of each piece.

5. Saw to gauge marks of piece *a* and cut to shoulder *c*.

6. Lay out with a knife, and cut shoulder *e*, $\frac{3}{8}$ " from the edge of *a*, and cut the dovetail on one edge only. The edges of this dovetail should be made a very little less than square, or they should be "cut under" so as to make the surface of the underside of the tail a trifle narrower than the upper, or face, side. The difference on the edges should be almost imperceptible when tested by the try-square. (If this is well done, it will insure a good joint on the face, but if it is cut under too much, the model may be ruined in trying to remedy it.)

7. Trim shoulders *c* and *e* with the chisel, if necessary; see Fig. 110.

8. Lay the dovetail of *a* in its exact position on *b*, and with a sharp knife make a distinct mark

beside each edge of the dovetail, and square on the edges of *b* to the gauge marks.

9. Cut out the slot to the gauge and knife marks, and trim them carefully with a sharp chisel.

10. If the work has been accurately done at every stage, the dovetail will have to be forced a little to bring it to its place.

11. Smooth and sandpaper. Do not glue the model together.

Figure 126 shows the same joint made at an angle of 90° .

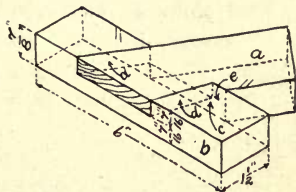


FIG. 125.—DOVETAILED BRACE, OR HALVED, JOINT.

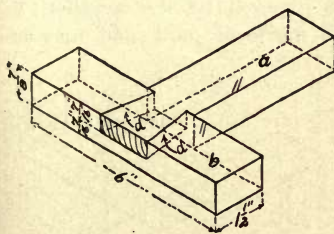


FIG. 126.—DOVETAILED LOCKED, OR HALVED, JOINT.

68. Mitered halved joint. Fig. 127.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

This joint may be used in making a strong corner at any angle where it is necessary to show a miter upon one side, in order to allow moldings to intersect, as in a heavy picture or a mirror frame. It is, as its name implies, a combination of the halved and miter joint, the miter occupying one half of the thickness; or, if a molding is being fitted together, the miter should be thick

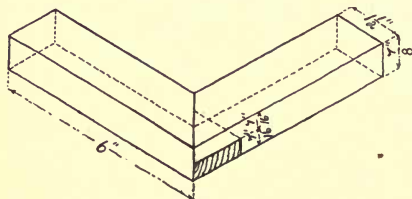


FIG. 127. — MITERED HALVED JOINT.

enough to insure that all the members of the molding will be upon one side of the half cut.

Smooth and sandpaper separately; do not fasten together.

69. Doweled joint. Fig. 128.

Material: 1 piece, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

1 piece, $4\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

If this joint is well made and not exposed to the weather, it is the most efficient substitute for the mortised joint, and may in general be used in any place where a mortised joint would be suitable; under certain conditions it is a stronger joint than that for which it is a substitute. For $\frac{7}{8}''$ material, a $\frac{3}{8}''$ dowel should be used; but for anything thicker, a $\frac{1}{2}''$ dowel is generally necessary to give the desired strength. In doweling thick material, the dowels should be placed as shown in Fig. 129.

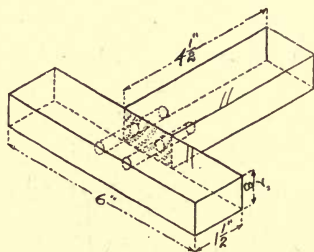


FIG. 128. — DOWELED JOINT.

A. Marking for dowels: Method 1.

The utmost accuracy is necessary in marking the centers of the holes and boring them, if satisfactory results are desired. The principal application of this method is in doweling the joints of a wide board.

1. Place the two pieces in the exact relative positions that they are to occupy permanently, as at A, Fig. 130,

2. Make a pencil mark across the joint upon the faces of both pieces at once, as at *aa*.

3. With either a pencil or knife, square across both edges of the joint from the marks, as at *bb* of B.

4. With a sharp gauge, make mark *c*, which crosses *bb*. The intersection of these two lines gives the center of the hole, or the point at which the point of the worm of the bit should be placed.

5. A scratch awl should be used to make a small hole at the above described point, so that the bit will enter accurately, as otherwise it is apt to enter a little to one side of the intersection, or to follow the

grain. The reason for this will be apparent if the point of the worm is examined, since it is the point of a spiral; hence, the point will have a tendency to push to one side when the worm enters the wood. Bore $\frac{3}{8}$ " holes 1" deep, and fit the dowels so that they may be pushed in with the fingers.

Smooth and sandpaper both pieces at once after the joint is made. Do not glue together.

Doweling an edge joint: In laying out dowel holes in preparation for gluing up a wide board, many workmen prefer an application of Method 1, and for medium-sized work it is quite as practicable, and often faster. Place the two pieces, as shown in Fig. 95, with the face sides out, and square across the edges of both pieces at once. With

a gauge, working from face sides, mark the distance from the face of the board to the center of the dowel holes, and proceed as in the previous problems.

Length of dowels: It is not wise to use a dowel longer than is necessary; one extending from $\frac{3}{4}$ " to $1\frac{1}{4}$ " each side of the joint will hold as

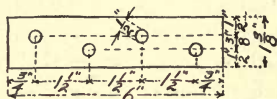


FIG. 129. — DOWELS IN THICK MATERIAL, PLACED "STAGGERING."

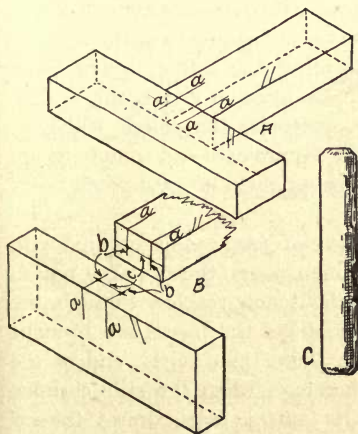


FIG. 130. — A, B, MARKING FOR DOWELS: METHOD 1. C, POINTED DOWEL.

well as one reaching farther into the edge of the side wood, for the reason that the wood between the joint and the end of the dowel will shrink, and the longer the dowel, the greater the width of wood there is to be affected. A longer dowel may sometimes be necessary in the wide stile of a door, to give sufficient strength to resist the slamming which a door receives. A dowel should be at least $\frac{1}{8}$ " shorter than the aggregate depth of the holes which are to receive it, and should be made loose enough to be pushed in with the fingers, but not loose enough to fall out or to be rattled around. The ends of the dowel should be pointed, as at C, Fig. 130. This allows some of the glue to be forced up between the dowel and the sides of the hole, and not all pushed before the end of the dowel, which would be the result if the dowel were square-ended; unless the dowel were too loose, in which case it would not have its full strength, as the joint would not be wood to wood.

Uniformity: In boring holes for dowels, it is the custom of many workmen to use one of the many forms of bit stops upon the market, in order to insure a uniform depth to all of the holes; others count the turns of the bit, from twenty to twenty-five giving the desired depth. This uniformity is necessary, otherwise the dowels will have to be cut to different lengths, which will require care and time to locate in their proper holes while the joint is being glued up, just when every second of time is precious.

Comparison of the mortised and the doweled joint: As compared with a mortised joint, when used upon common doors, the dowel is not so satisfactory as the mortise, because the tenon reaches through the stile, and the glue, collecting at the joint as the pieces are brought together, makes a stronger connection there than at the end of the tenon at the outside of the stile; therefore, when the stile shrinks, it usually holds at the joint, and its outside edge draws toward the joint, allowing the end of the tenon to project beyond the stile the amount of the shrinkage. In a doweled door, the joint would probably open.

The material used in making the ordinary grade of commercial doors is apt to be less thoroughly seasoned than it should be, and, as a rule, there are not enough dowels used to give the joint its maximum strength. Moreover, the dowels are generally placed in a straight line, instead of "staggered," as shown in Fig. 129.

If a door which is exposed to the weather is properly doweled, it will stand better than a mortised door in which the tenon passes through the stile, since in the latter case the moisture will quickly find its way into the end of the tenon, and the door will be rapidly destroyed. The mortises of an outside door should be of the type known as "blind," or "fox wedging," Fig. 141, as in this way the end of the tenon is protected from the weather.

When used upon furniture and other work which is set up in a warm shop, and when made of thoroughly kiln-dried lumber, a properly made doweled joint is perfectly satisfactory.

B. Gluing the dowels: The glue should be put in the hole, and not on the dowel; otherwise it will be scraped off as the dowel is pushed into its place, unless the latter is fitted very loosely, in which case the glue will soak into the end wood of the pieces being glued together, not leaving enough to hold the dowel firmly. The joint should be well fitted before the glue is applied; it should be forced together, and held in place by clamps until the glue has set. In preparing for gluing up wide boards, which are to be doweled, apply Method 1 of marking for dowels.

C. Marking for dowels: Method 2.

This method of marking for dowels is sometimes used when it is not practicable to use Method 1, as in doweling irregular forms. See Fig. 131.

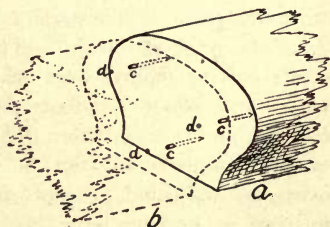


FIG. 131.—MARKING FOR DOWELS: METHOD 2.

1. Drive small brads, *c*, straight into the end of piece *a*.
2. Cut off the heads of the brads at about $\frac{1}{8}$ " from the wood.
3. Move piece *b* against *a*, being careful that the outsides are in just the right relation to each other, and apply enough pressure to make the brads leave imprints, *d*, in the end of piece *b*. These are the centers of the dowel holes.
4. Pull the brads out of piece *a*; the holes thus made are the centers of the dowel holes in that piece.

D. Marking for dowels: Method 3.

If it is desired to dowel irregular forms, or to make a number of joints just alike, this method will not only give good results and

save a great deal of time, but the pieces just alike will be interchangeable.

1. *Use of the templet:* Make a templet of pasteboard; or, if it is to be used indefinitely, of tin or zinc, as shown in Fig. 132, and through it prick small holes in the position which will denote the exact centers of the desired dowels, as at *a*.

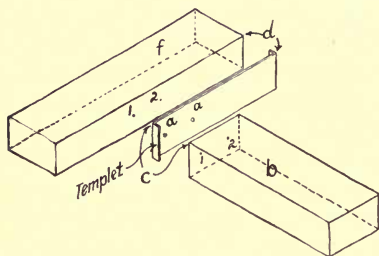


FIG. 132. — MARKING FOR DOWELS:
METHOD 3.

2. Place the templet upon the end of piece *b*, with the corner *c* of the templet at *c* of piece *b*, and flush with the face side; with a pricker, mark through the holes of the templet the centers of the dowels, 1, 2.

3. Place *d* of the templet on the edge of *f*, and flush with the face side, so as to coincide exactly with *d* of piece *f*. Through the holes *a a* of the templet, mark 1, 2 upon the edge of piece *f*. This method is much used upon large or irregularly shaped work of all kinds, as it permits of accurate work, and needs no tools but the templet and the pricker. The ends of the templet need not be turned over, as indicated, except for the purpose of making more rapid work possible.

70. **Mitered doweled joint.** Fig. 133.

Material: 2 pieces, $6'' \times 2\frac{1}{2}'' \times \frac{7}{8}''$.

Fit the joint; then fit the dowels by Method 1, Fig. 130.

A. Gluing a mitered joint: Method 1.

It is plain that a joint of this shape will be hard to clamp rigidly, but pieces *a* and *b* indicate a common method of holding joints of this nature. The same principle may be applied to any irregular forms. These pieces are glued on by a rub joint, after the miter joint is fitted; when they have set perfectly,

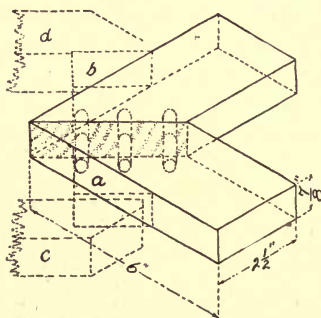


FIG. 133. — MITERED DOWELED
JOINT: METHOD 1 OF GLUING
ANGLES.

they are ready for use. It will be seen that they furnish a grip for the hand screws or clamps; therefore it is necessary that the faces which receive the clamps should be approximately parallel. The joint may now be treated as a doweled edge joint.

After the glue is set, remove the pieces *a*, *b* carefully; otherwise, they may take some of the wood of the model with them. Smooth and sandpaper the model.

B. Gluing a mitered joint: Method 2. Fig. 134 shows another method of holding a mitered joint, which is an application of the same

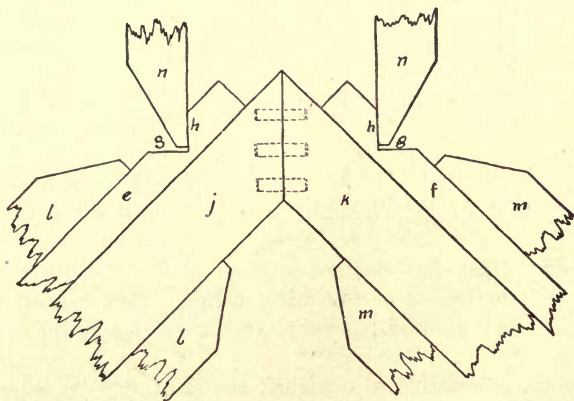


FIG. 134.—MITERED DOWELED JOINT: METHOD 2 OF GLUING ANGLES.

principle, its advantage being that it may be used without waiting for the glue to set. After the joint is fitted, the clamp strips *e* and *f* should be prepared of any convenient material, and notches cut in them as at *g g*, faces *h h* being parallel. These clamp strips should be held rigidly to pieces *j*, *k* by hand screws, *l*, *m*. After the glue is applied, hand screw *n* will hold the joint rigidly in place until the glue has set. Smooth and sandpaper the model. Either of the above methods may be applied in gluing pieces of any angle or of any irregular shape.

71. Miter box. Figure 135.

Material: 2 pieces, $16'' \times 3\frac{1}{2}'' \times \frac{7}{8}''$.

1 piece, $16'' \times 2\frac{1}{2}'' \times \frac{7}{8}''$.

This is an important adjunct to a kit of carpenter's tools, for if it

is made accurately, a perfect miter may be fashioned by its use. A box of this sort is of course inferior to an iron miter box, but it may be made at any time, while the iron box is unhandy to carry

around. A wooden box is accurate only when first made, but it may receive as many new cuts as the size of the box will permit.

Making the box: Joint the edges of the bottom perfectly square, and glue the sides upon them, holding the sides in place, until the glue sets, by means of hand screws.

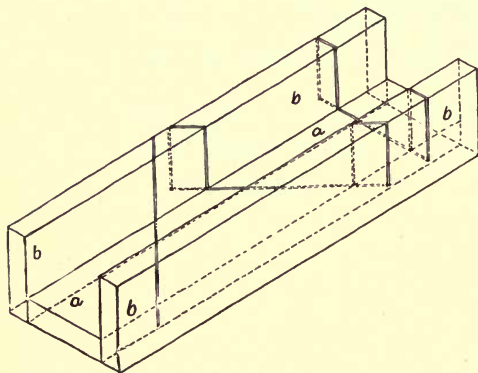


FIG. 135.—WOODEN MITER BOX.

Be sure that when the sides are in their places, their inside angles with the bottom are all perfect right angles. This form of wooden miter box is the most satisfactory, as there is no danger of sawing upon nails.

If it is not practicable to use glue, the sides may be nailed upon the bottom, though the saw will in time cut down to the nails, unless care is used that the cuts are made and the nails driven so that they will clear each other.

Making the cuts: The miter cut for a square miter may be found by the steel square (see Fig. 9), the inside top corner of the back of the box being the line upon which the steel square is placed in marking for the cuts. Any equal figures upon the outside of both the blade and the tongue held to coincide exactly with the top of the inside of the box, as described above, will give the angle. Lines should then be squared with a sharp knife to the bottom of the box upon both the inside and the outside, and cuts made to these lines with a keen, sharp saw, preferably with the one which is to be used in it. The life of a miter box is lengthened if but one saw is used, and that one with a very little set. Trim the ends of the box after it has been made.

72. Joggled and wedged splice. Fig. 136.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

This form of scarfed joint is used to lengthen timbers with the least possible sacrifice of shearing strength, the method used in making it being similar to that described in Topic 60. Like other forms of construction of this type, it is not used as much as formerly, on account of the development of steel construction. It is, however, valuable as an exercise in accuracy.

The cut at *a* is made at an angle of about 60° with the edges of the pieces, and should be about 3'' long. The angle of the joint should be ascertained by marking with a knife from the bottom of the cut of one edge to the face of *a* on the other. Transfer these lines to the other side of each piece.

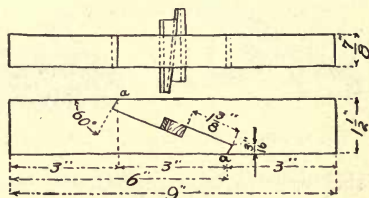


FIG. 136. — JOGGLED AND WEDGED SPLICE.

The key should consist of two wedges, made to fit the key way snugly; do not cut the keys to a neat, or close, length, but leave them long enough to run through, and allow for driving them to bring the joint to a perfect fit. Afterwards they may be cut off, say $\frac{1}{4}''$ from each side of the model.

73. Halved and rabbeted joint. Fig. 137.

Material: 2 pieces, $6'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

Panelwork is sometimes built by this form of construction, the panels being put in and fastened from the back with brads, as shown at *A*. Glass doors are often made with a rabbet in the back, the joints being

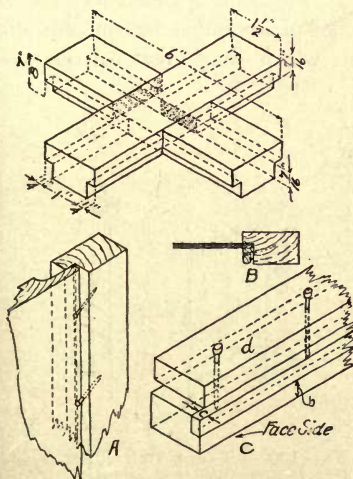


FIG. 137. — HALVED AND RABBETED JOINT.

held in place by a bead, as shown at *B*, or by putty, though the rabbet is to be preferred.

Rabbeting by hand: At *C* is shown the method of rabbeting by hand. Note that, as the piece is shown, it is lying face side down, as the rabbet is to be upon the back side.

1. Gauge from the face the distance, *b*; in this case, $\frac{7}{16}$ ".

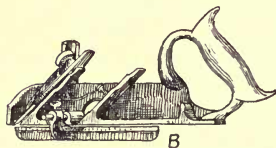
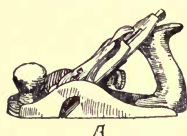


FIG. 138.—A, RABBIT PLANE. B, FILLETSTER.

2. Gauge from the edge to obtain the other dimension of the rabbet, *c*; in this case, $\frac{1}{4}$ ".

3. Place the fence piece, *d*, directly upon

the piece to be rabbeted and hold the fence piece with small brads. Its purpose is to guide the rabbet plane (*A*, Fig. 138) in making the first cuts. The plane should be stopped directly at the gauge mark, *b*.

This joint is simply an elaboration of the halved joint, the same methods of cutting and fitting being used as in Topic 61.

A plane known as a "filletster" (*B*, Fig. 138) is constructed upon the same general principle as the rabbet plane, but it has, in addition, an adjustable depth and width gauge, which are a great convenience upon this kind of work, as their use makes the fence, *d*, and the gauge marks, *b* and *c*, superfluous.

Do not fasten this joint together with glue.

74. Table leg joint. Fig. 139.

Material:

1 piece, $4\frac{1}{2}$ " \times $2\frac{1}{2}$ " \times $2\frac{1}{2}$ ".

2 pieces, 6" \times 3" \times $\frac{7}{8}$ ".

As its name implies, this joint is used to fasten the rails and legs of a table together.

It is an application of the mortised and the relish joint, Topic 66, but it has a shoulder upon the face side only, as at *a*. This saves making two cuts upon each end of each rail, and gives a thicker and stronger tenon. The dowel joint is frequently used as a substitute.

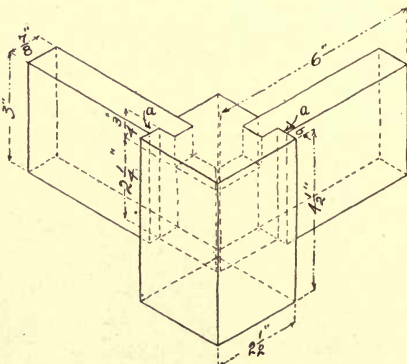


FIG. 139.—TABLE LEG JOINT.

The mortise gauge should be used in marking the leg for the mortise; a sinkage of from $\frac{5}{16}$ " to $\frac{1}{2}$ " should be allowed at *b*. In cutting the tenons on the ends of the rails, we have an illustration of a case in which it is best to work from the *back* side, instead of from the face, as the thickness of the tenon must be marked from that side. The joint is sometimes drawbored from the back side, which adds much to the strength of the table.

Smooth and sandpaper separately, and do not glue together.

75. Double mortised joint. Fig. 140.

Material: 1 piece, $12'' \times 2'' \times \frac{7}{8}''$.

1 piece, $7'' \times 5'' \times \frac{7}{8}''$.

A. Comparison of a wide and double mortised joint: Where wide rails are used, such as the middle and bottom rails of a large panel

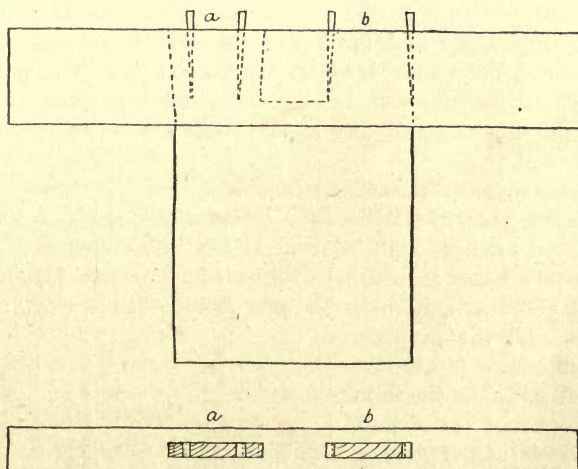


FIG. 140. — DOUBLE MORTISED JOINT.

door, a single mortise would cut away too much wood, and make a tenon of too great width. The middle of the length of a mortise long enough to receive a very wide tenon, would have little strength, as the wood would all have been cut away, and that on each side of the mortise would not be stiff enough to give the joint the

strength and rigidity it should have. By making two tenons instead of one, the shrinkage of a wide tenon is distributed, and the liability of breaking the glue connection is much decreased. In driving the wedges, they should be driven as at *a*; not beside the tenon, as at *b*, though this is the method usually followed upon common work.

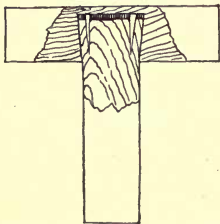


FIG. 141. — BLIND, OR FOX-WEDGED, MORTISED JOINT.

B. Blind, or fox, wedging: Upon the best grades of work, the wedges are frequently entered as shown in Fig. 141, which is called "blind," or "fox," wedging. In this, the mortise is cut longer at the bottom than at the top, and when the tenons are forced into their places by the clamps, the wedges are pushed into the cuts made to receive them, thereby

spreading the tenon and forming a dovetail, which makes a very strong joint. This joint is often used upon the best grades of outside doors, as the end of the tenon is not exposed to the weather. Good judgment and careful work are necessary to make this joint well.

76. Coped joint. Fig. 142 (sash joint).

Material: 1 piece, $6'' \times 2\frac{1}{2}'' \times 1\frac{3}{8}''$. Molded on one edge.

1 piece, $4'' \times 1'' \times 1\frac{3}{8}''$. Molded on two edges.

This material may be secured at a sash factory or a planing mill, though the student may make his own molding, as a straight bevel will answer all the purposes of this problem.

"Coped joint" is the term applied to that form of butt joint in which the end piece, *a*, is fitted to the molded edge of piece *b*, the end of piece *a* being cut to fit the contour of piece *b*. The fact that the connection may be strengthened by a mortise, as it is in Fig. 142, or by a tongue and groove, as it is in *C* and *E* of

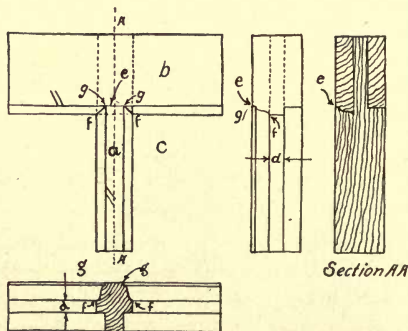


FIG. 142. — COPED JOINT.

Fig. 143, does not alter the fact that the coped joint itself is an elaboration of the square butt joint.

Uses of the coped joint: A coped joint shows a miter on its face, as in the face view at *C*, Fig. 142; it is used in many places where moldings intersect, and it is desirable to show a miter, as in cutting in base moldings, as at *A*, Fig. 143, or room moldings, as at *B*. It is chiefly employed upon moldings of small dimensions. In practice, if an inside joint is mitered, the joint will be nailed open when the nails are driven; but if it is coped, the full length piece, *b*, of *A* and *B*, Fig. 143, is nailed firmly into its permanent place, and the coped pieces, *a*, are cut long enough to allow them to be sprung and forced into making a perfect fit.

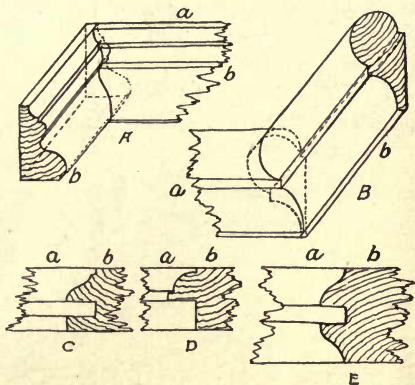


FIG. 143. — USES OF THE COPED JOINT.

Fitting a coped joint: In describing this exercise, the joint of a sash has been taken as a model. After the pieces are prepared, proceed as follows:

1. Mark tenon on *a*, and mortise on *b* of Fig. 142, so that they will each come in the flat inside edge, *d*; cut them, working only to the shoulder, *e*.

2. Place *a* in a miter box and cut the miters *f*, *g*, mitering the molding only. As a coped joint shows a miter, this will give the edge, or line, to which the end must be cut.

3. With convenient sizes of chisels and gouges, cut away the wood, leaving the mitered edges *f*, *g*, of piece *a*, as shown in section *AA*; cut back far enough so there will be no wood to prevent piece *a* from fitting perfectly against the edge of *b*, but be careful not to cut back of the edges, *f*, *g*, on the surface of the molding, or back of the shoulder, *e*, on the face of piece *a*. Cut the pieces to the desired length, smooth and sandpaper them.

Forms of this joint are used in making ordinary grades of panel-work and stock doors; see *C*, *D*, *E*, Fig. 143.

77. Wedged and halved scarfed joint. Fig. 144.

Material: 2 pieces, $6\frac{3}{8}'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$.

This joint is used in heavy wooden construction in places where it is necessary to have the greatest tensile strength, though it is obviously a weaker joint in regard to resistance to a shearing stress, if concentrated at the joint, than is that described in Exercise 72.

After the pieces *a* and *b* have been accurately squared and made parallel, proceed as follows:

1. *Fitting the joint:* Lay the pieces side by side in their relative positions, and with a sharp knife mark distinctly, by the edge of *a*

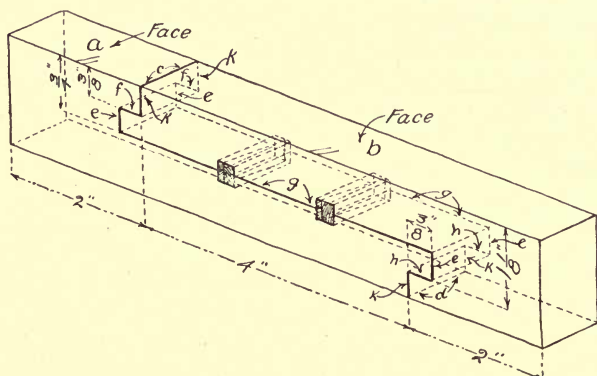


FIG. 144. — HALVED AND WEDGED SCARFED JOINT.

square, the lines *c*, *d* upon both edges of each piece. Notice that the lines are 2'' from one end of each, and $\frac{3}{8}''$ from the other end.

2. With a fine, hard pencil, mark lines square with the edges lightly upon both sides.

3. With a sharp gauge, lay out upon both sides of each piece in the order given, the lines *f*, *g*, *h*; be careful not to continue the lines beyond the point where they will cut away, or they will cause a blemish upon the finished model. Work from the face side and edge at all times.

4. Go over *c*, *d*, *e*, *k* with the knife, carefully.

5. In cutting to the marks, leave half of the knife or gauge marks upon the piece wanted. Saw in the following order: *c*, *k* to *C*, and *d*, *k* to *g*, *f*, *h*. With a sharp chisel, cut *e*, cutting back of the lines in

the thickness of each piece. To insure a tight fit at *g*, the joint should be perfectly straight: if there is any deviation, it should be a little rounding in its length. If this should be done very carefully, and if all the work is executed with accuracy, all members of the joint will fit perfectly.

6. After all the fitting is done, clamp the pieces in their permanent position, and with a knife mark the key ways and fit the wedge keys, which may be allowed to project $\frac{1}{4}$ " upon each side, if desired.

7. Smooth and sandpaper.

78. Plain dovetailed joint. Fig. 145.

Material: 2 pieces, $4\frac{1}{2}" \times 3" \times \frac{7}{8}"$.

This joint is rarely used upon anything but the most expensive work, as it requires a high degree of skill to make it economically. It forms the strongest possible unreinforced joint for the corners of boxes, chests, etc.

A. Laying out and cutting the dovetails:

In making a dovetailed joint, some workmen lay out and cut the pin, *a*, first, which necessitates that the tails, *b*, should be marked and cut one at a time. Good results may be obtained by this method, but it is slow, and is rarely used upon practical work. The common method

used by workmen is to saw the tails, *b*, first, and mark the pins by the tails. If two or more joints are to be dovetailed alike, the sides may be made into a bunch, and all sawed at once, as shown in Fig. 146.

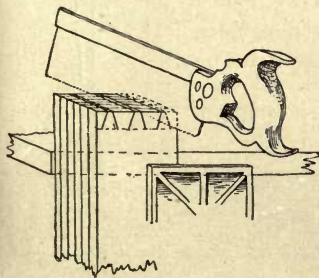


FIG. 146.—SAWING DOVETAILS.

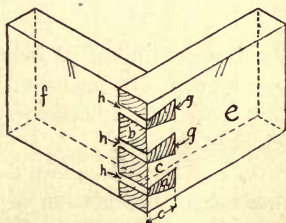


FIG. 145.—PLAIN DOVE-TAILED JOINT.

The pieces for this exercise should be prepared about 2" longer than actually needed, as it is possible that the first attempt will be a failure.

1. Make the ends to be dovetailed perfectly square and true.

2. Gauge upon each side from these ends, the distance, *c*, or the thickness of the piece to be dovetailed.

3. Place *e*, or the tailpiece, in the vise, end up, and face side toward the

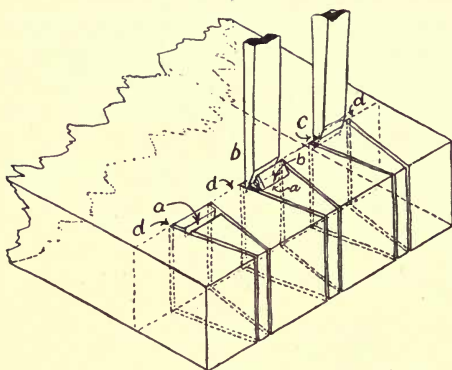


FIG. 147.—CUTTING DOVETAILS.

workman. Beginning at an equal distance from each edge, say $\frac{5}{8}$ " , mark the distance, h , of the two outside tails. These should be rather small, not more than $\frac{3}{16}$ " . Lay out an equal distance halfway between these two for another tail.

4. Mark the bevel of the pin; this may vary, but the bottom, g , of the tail, should not be more than $\frac{9}{16}$ " for $\frac{7}{8}$ " stock. If

the angle of the tail is too sharp, it is apt to be broken off when the pieces are driven together.

5. Saw with a backsaw, in every case leaving the line of the piece which is wanted.

6. Lay the pieces face down upon the bench, and with a chisel narrower than the bottom of the cut, make one cut, as at a , Fig. 147. This will minimize the tendency of the chisel to push back, so that when the next cut is made upon the line d , the wood will break into cut a , as at b , instead of pushing the chisel back of line d , as at c , which will probably happen if cut a is omitted.

7. The gauge mark, d , at the bottom of the pin cut upon both sides should be kept perfectly straight, and the cut be made exactly to this line, as a straight piece of wood is to fit against it. The section of the cut should be similar to d , Fig. 148, and half of it cut from each side, holding the chisel, as shown by the try-square at a , so as to cut under, which will allow the edges b, c to fit closely against the pin. The novice is more than likely to make a cut that will be full in the middle

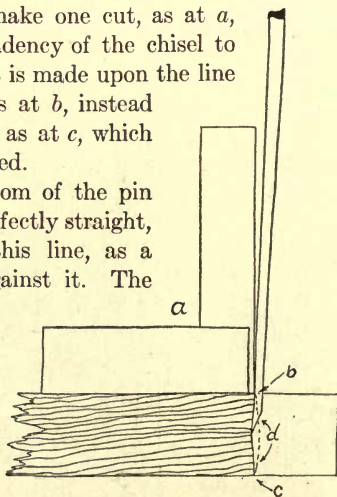


FIG. 148.—SECTION OF DOVETAIL.

of the thickness of the board, shown by the dotted line at *d*, which will prevent the pin from making a good joint at *b* and *c*. Grasp the chisel as shown in Fig. 121.

8. Turn the piece over, face up, and make the cut from that side; clean out the chips, or core.

B. Marking and cutting the pins.

1. Place *f*, of Fig. 149, in the vise in a vertical position.

2. Place piece *e* upon the end of piece *f*, as indicated. It is important that the mark *d*, which is the same

as *d* of Fig. 147, should exactly coincide with the corner, or the back side, of piece *f*. The relation of the ends of the tails of *e*, with the face of *f*, at *h*, is of no importance, providing they are long enough to come

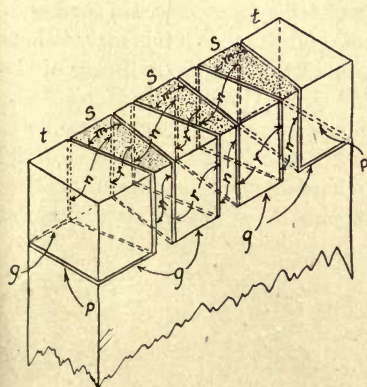


FIG. 150. — DOVETAILING ; SAWING PINS,

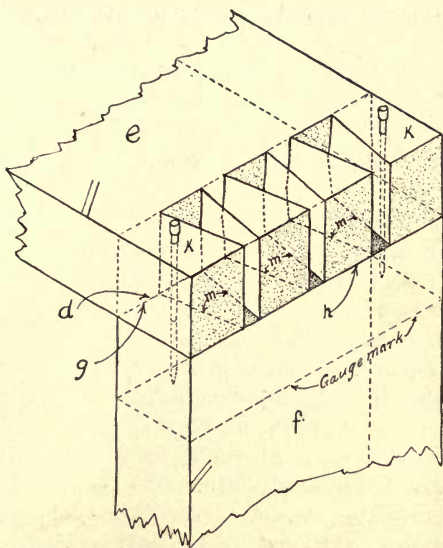


FIG. 149. — DOVETAILING ; MARKING PINS.

flush, or project by the face of *f*. If piece *e* cannot be held firmly enough to allow of accurate marking, it may be held by small brads driven through the tails, as at *k*. Avoid doing this if possible, as the holes will show in the finished model.

3. Remove piece *e*, and with try-square and sharp pencil, or knife, mark lines, *n*, upon the face and back side of *f*, as in Fig. 150.

4. With backsaw, cut down to lines *g*, as shown by double lines, being careful that in every

case the cut is made outside of m and n , or that these lines are left on the pin.

5. Turn the piece over in the vise so that the cuts p , g may be made in each edge. These should be made exactly to the line upon each surface of the cut, with a backsaw. This will cut out the corner, t . If the work has been accurately done, these corners should not be touched again.

6. Clean out the spaces, r , with a chisel by the same method used in cutting the tails. See A 6, of this topic.

7. If this work has been done with sufficient accuracy, there will be no need of trimming either the pin or the tail to allow the two pieces to come together and make a perfect joint. To attain this accuracy should be the ambition of each student, as the skillful workman must be able to make dovetails rapidly, surely, and without trimming. In cutting the pins, the amateur is quite as likely to cut inside as outside of the lines, thus making the pins too small; this tendency should be guarded against, and the pins, s , s , s , left the exact size desired. In every case, the saw cut should be made with such care that chiseling or fitting will be unnecessary, as it is quite as likely to injure as to improve the joint.

8. The inside of both pieces should be smoothed and sandpapered before being put together permanently; and care should be taken not to plane any off of the back side of the pins, or they may be too small. If the pins fit too closely, with a hammer bruise the corners of their ends a little, where they enter the space between the tails; this makes them a little smaller, but when they are glued together, the moisture of the glue will swell the pins to their normal size. Glue the pieces together, being sure that the angle of the joint is square; apply the glue sparingly.

If the work has been done accurately, the joint should be so tight that when it is set away for the glue to harden, it will hold itself together without the aid of hand screws; though if necessary, these may be used judiciously.

9. Smooth and sandpaper.

79. Half-blind dovetailed joint. Fig. 151.

Material: 1 front, $4\frac{1}{2}'' \times 3'' \times \frac{7}{8}''$.

1 side, $4\frac{1}{2}'' \times 3'' \times \frac{1}{2}''$.

This is the joint which is used in the construction of drawers upon the best grades of work. (In laying out the dovetails of a drawer side,

care should be used that the groove for the drawer bottom comes in one of the tails, for if it comes in a pin, it will show upon the end of the drawer front.) As this is the form of dovetailing used the most, there have been several machines invented for the purpose of dovetailing drawers, and the work of the best of these is equal in strength to the work done by hand, though no machine has yet been devised which will exactly reproduce hand-made dovetails.

In making the half-blind dovetailed joint, we have another instance in which it is necessary to work from the back, instead of from the face of the front, as we will designate the $\frac{7}{8}$ " piece.

After the pieces have been prepared as described in the last paragraph of Topic 78 A, proceed as follows:

1. *Marking and cutting the joint:* Set the gauge to the thickness of the side, and gauge upon both sides of the end of the side which is to be dovetailed, as at *a a*. Without changing the set of the gauge, working from the back corner, or corner *b*, of the back of the front, make gauge marks, *c*, which indicate the length and depth of the space that must be cut out from between the pins, *d, d, d*, and the corners, *e, e*.

2. Lay out, saw, and cut the dovetails upon the end of the side. Mark the pins upon the end of the front, being careful that the lines *a* of the side, and *b*

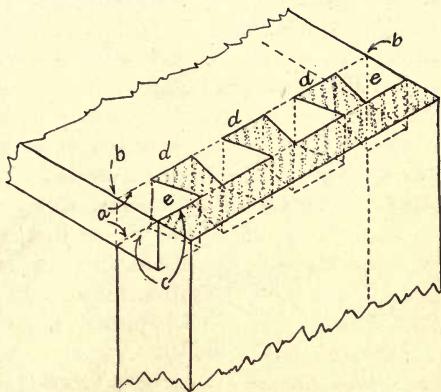


FIG. 151. — HALF-BLIND DOVETAILED JOINT.

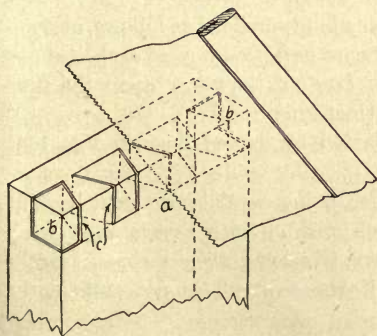


FIG. 152. — HALF-BLIND DOVETAILED JOINT;
SAWING THE PINS.

of the front, coincide perfectly, and proceed by the same method as in the preceding problem. The experienced workman learns to make the cut without the guide lines *c*, of Fig. 152, with sufficient accuracy to insure a good fit, but the amateur should be cautious in attempting methods of work which are beyond his skill.

3. Saw the pins as indicated in Fig. 152 at *a*, and with a chisel cut out the rest of the space which is to receive the dovetails of the side. Workmen who have much of this to do generally have a short, stout chisel, which may be handled more easily than one of the ordinary size. Cut out corners, *e*, with a backsaw, as far as possible, placing the piece in the vise so that a nearly vertical cut may be made on all sides, as it is difficult to make an accurate cut in any other position.

4. Smooth and sandpaper the inside of the model.

5. Glue together, smooth and sandpaper as in the plain dovetail.

80. Blind dovetailed joint. Fig. 153.

Material: 2 pieces, $4\frac{1}{2}'' \times 3'' \times \frac{1}{4}''$.

On account of the time and skill necessary to make this joint, and from the fact that after all the work has been done, it appears no different from an ordinary miter joint, it is used only upon the finest work. It is, however, an excellent exercise in accuracy.

In making this joint, proceed as follows, observing the utmost care and accuracy at each step:—

1. *Marking and cutting the joint:* Lay out the miter upon the four surfaces of each piece, making a distinct knife mark.

2. Lay out the square *a a*, indicated by dotted lines in Fig. 154, which is to receive the dovetails.

3. Cut the square *a a* to exact size, being careful not to cut beyond the miter lines, using a backsaw and finishing with chisels.

4. With a backsaw cut the miters, trimming with a chisel exactly to surface lines and to lines *b*, if the saw cut is not sufficiently accurate.

5. Mark the tails in the square of piece *B* and cut them by the same method used in cutting the spaces between the tails in the previous

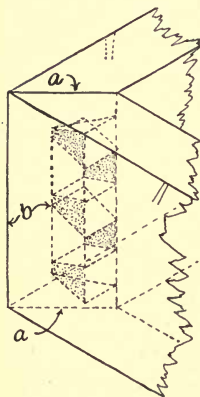


FIG. 153. — BLIND DOVETAILED JOINT.

problem. To assist in accurate marking, make a templet of a piece of thin cardboard or zinc, similar to that shown in Fig. 132, on which the bevels of all the teeth are carefully laid out, and cut and use this to mark the bevels on both pieces. This may be done by measuring, if desired, but a templet makes more accurate work possible.

6. Lay out and cut the pins, using the templet. If a large piece of this form of construction is being made, the marking may be done by the same method as in Topic 78.

7. This joint should not be glued together, as the construction cannot then be seen. Smooth and sand-paper as in the preceding problem.

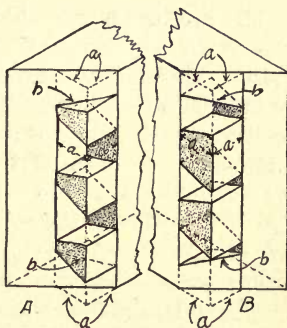


FIG. 154.—BLIND DOVETAIL:
METHOD OF FITTING THE
JOINT.

SUGGESTIVE EXERCISES

47. What nature of wood is best adapted for use in the work of this chapter? What kinds of wood? Why should not files, rasps, or sand-paper be used in making joints? Should pieces be cut to their exact length before fitting the joint? Why?

48. Demonstrate the process of "lining off." How should saw cuts be made in relation to guiding lines and the pieces wanted? What are the probable results of forcing a saw? Describe and give reasons for the progression in squaring up a board. How should a straight edge be tested? Why should a block plane not cut from edge to edge across the end of a board? How prevent the bench dog from bruising the end of a board? Describe the face edge. Why is it important?

49. Why is Exercise 50 *L* omitted in most of the work of this chapter? What should be guarded against while cutting grooves with a backsaw and chisel? Demonstrate method of holding work and using tools in cutting grooves.

50. Why use knife in making marks demanding accuracy? Describe uses of the square butt joint. Give a good general rule which applies to cutting and fitting stock.

51. Describe the uses of an end butt joint.

52. Are best results obtained if an edge or glue joint is in perfect contact the entire length? Why? For what is an edge joint used? What is apt to happen if the joint is forced by clamps too much? Describe method of joining both edges of a board at once. Describe method of joining boards less than 4 ft. long. What is meant by the "face mark"? What is meant by "end for end"? What is meant by "out of wind"? How should a well-made joint appear to a trained eye? If a joint is well made, how many clamps are necessary in gluing it up? Describe a rub joint, and process of making it. Should a joint be made "wood to wood," or should there be a perceptible line of glue? Describe conditions under which glue should be used. Describe the glue room of a factory. Describe preparations for gluing. Describe process of gluing. What tools are used in preparing for sandpaper? How should sandpaper be held around the block? How should curved surfaces be sandpapered? At what stage of the work should sandpapering be done? What is the result if edge tools are used after sandpapering? What should the workman guard against in sandpapering around curves or square corners? How should a sharp corner be treated? How should sandpaper be used in relation to the grain? What exceptions to this rule? What is the danger in the use of sandpaper by an amateur?

53. Describe an intersection joint and its uses.

54. Describe a lap joint and its uses.

55. Describe a fished joint and its uses. How is it strengthened for heavy work?

56. Describe a mitered joint and its uses. Demonstrate method of placing different forms of moldings in the miter box. Describe method of mitering by a bevel. How should a molding with a finished face be held in a vise?

57. Describe a halved scarfed joint: its uses; method of making. Demonstrate method of trimming a joint with a chisel. How should a halved joint be supported when used as a girder?

58. Describe a tapered scarfed joint and its uses. Compare it with the halved joint. Describe method of making.

59. Describe the lock joint; its uses, and process of making.

60. Describe the housed or tank joint and its uses. How should it be made thoroughly water-tight? How may the bottom of a sink be made water-tight?

61. Describe a beveled or halved joint and its uses.
62. Describe a checked joint and its uses.
63. Describe a mortised joint. Name its two parts. What kind of gauge should be used in making this joint? Describe method of marking and cutting both members of the joint. Describe method of grasping chisel for accurate work. Describe drawboring and its uses.
64. Describe a mortised joint and relish and its uses.
65. Describe a dovetailed brace joint; its uses, and process of making.
66. Describe a mitered halved joint and its uses.
67. Describe a doweled joint and its uses. Compare it with a mortised joint. What size dowel should be used for $\frac{7}{8}$ " materials? for material an inch or over in thickness? How should dowels be placed in thick material? Demonstrate the process of marking for dowels and of making a joint. Compare long and short dowels. How should a dowel be glued? How long should a joint remain in the clamps if made with cold glue? If made with hot glue? Describe process of marking dowel holes with brads; with a templet.
68. Describe a mitered doweled joint and its uses. Describe two methods of gluing.
69. Describe a miter box and its use. Compare iron and wood boxes. How should a wooden box be made? Demonstrate method of laying out a miter.
70. Describe a joggled and wedged splice. Describe its uses.
71. Describe a halved and rabbeted joint and its uses. Describe the rabbet plane and its use.
72. Describe a table-leg joint. What joint is often substituted?
73. Describe a double mortised joint and its uses. Demonstrate different methods of wedging.
74. Describe a coped joint and its uses. Describe process of making it. Compare it with a mitered joint.
75. Describe a wedged and halved scarfed joint. Describe its uses. Demonstrate method of making joint.
76. Describe a plain dovetailed joint: its uses, and method of making. Demonstrate the method of holding a chisel. What should be guarded against in smoothing the inside of the pin member?
77. Compare the plain dovetail with the half-blind dovetail. What should be considered in laying out the dovetails of a drawer side?
78. Describe a blind dovetailed joint. Why is it not used commonly?

CHAPTER IV

SUPPLEMENTARY MODELS

THE construction of the following supplementary exercises is based upon the problems discussed in the previous chapter. It is assumed that the student has, by the preceding exercises, gained a knowledge of tools and processes sufficient to enable him to select wisely those which he should use to accomplish certain results; therefore these models are intended to be only suggestive, and it is not necessary to follow the course as outlined. Any model may be selected which is of approximately the same degree of difficulty as those described. Specified exercises will not generally be mentioned, but at each step the previous work should be reviewed, and its application to the work in hand carefully considered. Complete dimensions of models are sometimes purposely omitted, as the student should use his judgment in developing a working drawing from the sketch of each model that he makes. The stock lists are made out for a few of the models simply to indicate the method to be followed in making out the lists for others, and not for the purpose of making the work easy. Unless noted otherwise, the following models may be made of any soft wood. In making them, the student should in each case first make a working drawing, being guided by Chapter II. A stock list should be prepared by the method indicated

in those following. The exact dimensions should be placed upon the stock list in the order given, — length, width, and thickness, though in some localities the order is thickness, width, and length. Allowance for working should be made when the stock is cut.

81. Bench hook. Fig. 155. (See Handbook: Fig. 14.)

A. Stock list: 1 cutting board, $12'' \times 6'' \times \frac{7}{8}''$.

1 hook, $2\frac{1}{2}'' \times 6'' \times \frac{7}{8}''$.

1 rest, $2\frac{1}{2}'' \times 4'' \times \frac{7}{8}''$.

B. Length and width of wood: In the above dimensions, which are given in the order of length, width, and thickness, it will be noticed that the last two items are wider than they are long. It is the invariable custom that the length of a board shall be parallel with the

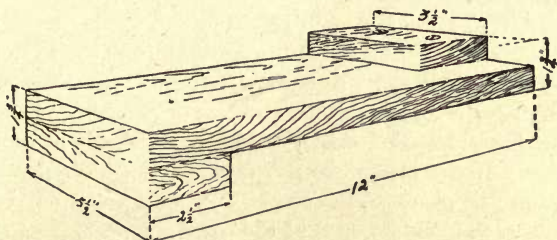


FIG. 155. — BENCH HOOK.

grain, and the width at right angles to it. This model is useful upon the work bench for the purpose of holding work while it is being cut (see Figs. 88 and 90), and of providing a place upon which all cutting should be done, as a cut should never be made directly upon the bench with any sort of cutting tool.

C. Sequence of work: 1. Prepare one piece $\frac{1}{4}''$ wider and $2\frac{1}{2}''$ longer than necessary to include all the pieces in one length.

2. Plane one edge, and block plane each end straight and square, regardless of the length of the piece.

3. Cut one piece $3''$ long from each end, and make one piece of the required width for the rest, or narrow piece.

4. Plane the cutting board smooth, but do not sandpaper it.

5. The vertical distance between the inside faces of the hook and

the rest should, of course, be 7", which should be laid off in the middle of the length of the cutting board. Indicate the location of the hook by two knife points (not a mark) the entire width of the board. Locate the rest upon the opposite side of the board by the same method, as shown in the sketch. In placing both pieces, the squared end should form the vertical faces. *Do not mark with a pencil, as the black mark will disfigure the finished model.*

6. Bore screw holes in the hook and in the rest, using a German bit, and countersink the holes; by this is meant the boring of a hole which tapers from the surface of the board to the center of the hole, and which allows the screw head to be driven flush, or below the surface of the wood. Hold both pieces in their exact places, and with a hammer tap the screws lightly, but sufficiently to mark the holes in the cutting board; remove the pieces preparatory to gluing, and bore small holes in the cutting board to receive the screws.

7. Be sure that both the small pieces fit the cutting board; spread the glue *sparingly* upon the side of the hook which is to form the joint, and force it into its place by screws. Do the same with the rest, and whether the joint is as good as it should be or not, apply hand screws to force the pieces of wood closely together, and hold them while the glue hardens. If the pieces are not held firmly, the moisture of the glue will cause the pieces to swell upon the sides which have received it, thus causing the joint to open at the edges.

8. After the glue has hardened, treat the pieces as one, cut to length, blockplane the ends, plane to width, and make the model square and true. If the work is planned and executed accurately, each of the three pieces will finish the size called for in the stock list.

82. Coat hanger. Fig. 156. (See Handbook: Fig. 18.)

Material: 1 piece, $15\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{7}{8}''$.



FIG. 156. — COAT HANGER.

A. *Drawing curves through given points:* Make the piece square and parallel, and mark the intersections of the curves upon it from the di-

mensions given; these marks should be made upon the face side, as shown in the sketch, and curves should be carefully drawn through the intersections, as indicated. They should be drawn free hand; by resting the elbow upon the bench, and using it as the center of an arc, an almost perfect curve may be made. In working down to these marks

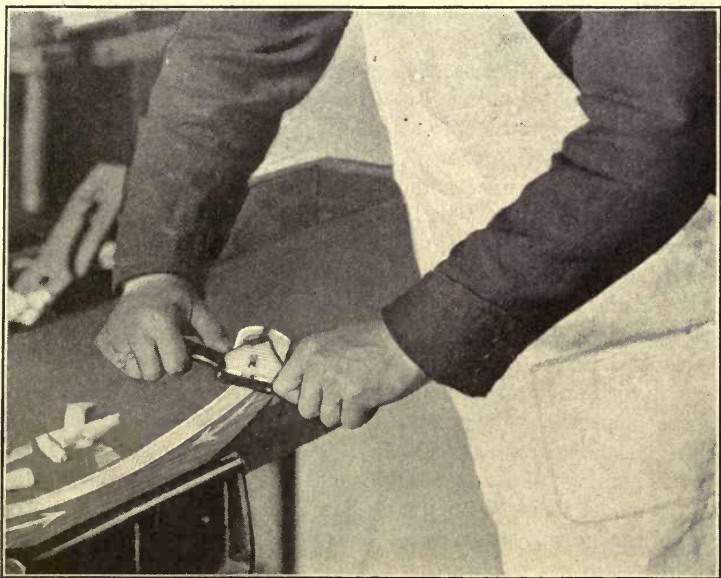


FIG. 157. — USE OF THE SPOKESHAVE — TAKING ADVANTAGE OF THE GRAIN.

with a compass saw, or with a frame or turning saw, care should be used that the marks are not cut off. (A *frame saw* is simply a small buck-saw; it is preferred by many workmen for nearly all purposes for which a compass saw would ordinarily be used, as it does not bend nor break so easily, and the arc of a smaller circle may be cut.)

B. Sawing "under": It seems that every novice has an irresistible tendency to "cut under" in a case of this sort; that is, to make the back side of a piece of work smaller than its face: the result of this is, that the piece must be cut below size, or the edge finished out of square, neither of which is permissible. To prevent this, the edge of the blade

should be carried as nearly as possible at right angles with the face of the board, and about $\frac{1}{8}$ " outside of the mark.

C. The grain: Study the direction in which the grain runs, and as the spokeshave is to be used, the student should be careful to work in the direction in which the tool cuts without tearing the grain. The method of grasping the spokeshave is shown in Fig. 157, and the direction indicated by the arrows should be the direction of the cut of the spokeshave upon the inside of the model. If these directions are reversed, the wood will generally be badly torn, as the cut will be against the grain. Upon the outside of the coat hanger, the stroke should be made from the middle to the end.

D. Use of the wood file: This is the first model upon which the wood file should be used, and here only in smoothing off a curve after the spokeshave has done all that it can. Unless care is exercised with this tool, the sharp corners of the work may be chipped off and destroyed.

E. Machine planing: Boards which have been run through the planing machine are not ready for the sandpaper; they should always be smoothed with a smoothing plane, as it is almost impossible to remove with sandpaper the minute ridges which are left by the planer at right angles with the grain of the wood.

F. Smoothing and sandpapering: The term "smoothing" applies only to planing; if sandpapering is meant, it will be noted separately.

This model should receive a shellac finish, well rubbed down; one coat of shellac will be enough, if it is not too thin, and provided it is finished with wax finish and well rubbed.

83. Foot rest. Fig. 158. (See Handbook: Fig. 37.)

Material: Any wood of medium hardness.

1 top, $13'' \times 8\frac{1}{2}'' \times \frac{7}{8}''$.

4 legs, $6\frac{1}{2}'' \times 1'' \times \frac{7}{8}''$.

2 side rails, $12\frac{1}{2}'' \times 1\frac{3}{4}'' \times \frac{5}{8}''$.

2 end rails, $8'' \times 1\frac{3}{4}'' \times \frac{5}{8}''$.

Make allowances for working beyond listed dimensions.

In this model the joints are locked, $\frac{3}{16}''$ being cut out of each leg and intersecting rail, allowing the latter to project $\frac{1}{4}''$ beyond the legs.

A. Fitting locked joints: Care should be used in cutting the joints, as the sides of the cut must be square with both the face sides and the edges. It is safer to make the cuts very close, since it is better to have

to trim a little, than to have an open joint. As the student gains skill, the correct cut will be made the first time. See Topic 61.

B. Cutting "standing": Contrary to the tendency of the amateur in the previous model, his tendency in work of this sort is to cut "standing"; that is, to make the sides of the cut wedge-shaped toward each other, thus preventing the piece, which is supposed to fit, from coming to a joint. In theory, a joint of this sort should always be cut perfectly

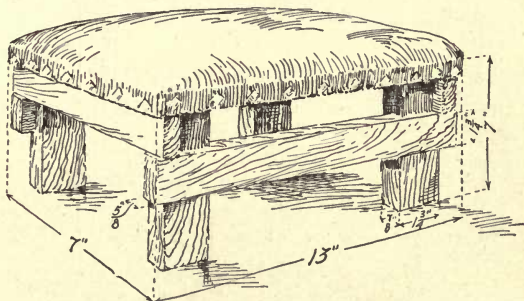


FIG. 158.—FOOT REST.

square with the face; but in practice, either it should be cut slightly under, or the bottom of the cut should be made a very little larger than at the face of the joint, in order to insure a perfect fit upon the face.

C. Smoothing and scraping: These pieces should be smoothed, scraped, and sandpapered before being glued together. The top should be put on by dowels, by Method 2, Topic 69.

Finishing: This model may be finished in the natural wood by a filler and shellac, or by a stain with either a shellac or a wax finish.

Upholstering: If desired, the top may be made of any ordinary wood, and upholstered by covering it loosely with cotton cloth fastened on three edges, and filled from the fourth with curled hair, moss, or tow. It should then be covered with the desired material, which should be fastened to the edge with common tacks, and the latter covered with gimp and ornamental upholsterer's tacks.

84. Tool box. Fig. 159.

Material: Pine or poplar.

1 bottom, *a*, $20'' \times 12'' \times \frac{1}{2}''$.

1 partition, *b*, $18\frac{1}{2}'' \times 7'' \times \frac{5}{8}''$.

2 sides, *c*, $19'' \times 3\frac{1}{2}'' \times \frac{1}{2}''$.

2 ends, *d*, $10\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{1}{2}''$.

1 handle, *e*, $7\frac{1}{2}'' \times 1\frac{1}{4}'' \times 1\frac{1}{4}''$.

A. *The bottom and sides:* The bottom of this box should not be cut to the exact size until the ends and sides are nailed together, on account of the possibility of variation, as the bottom is to fit the rim, and not the rim the bottom. The student will notice that the partition

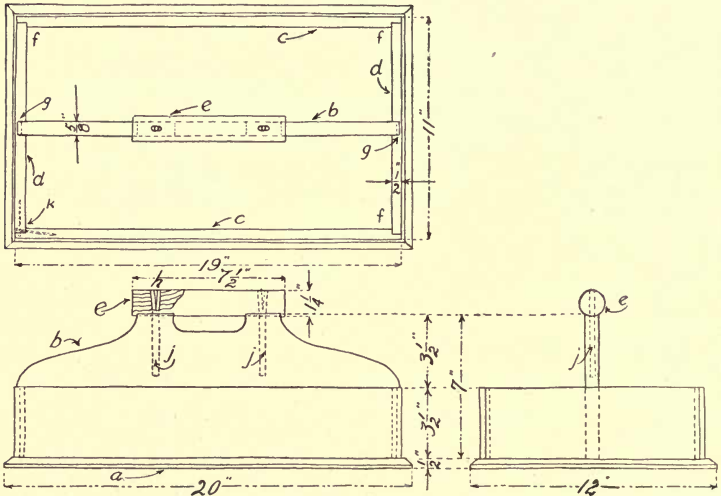


FIG. 159. — TOOL BOX.

is halved, or housed, into each end, as at *g*, and the ends into the sides, as at *f*, each joint being cut halfway through the thickness of the stock. The curves of the partition should be carefully studied, and accurately worked out.

B. *The rim:* The sides and ends of the rim should be smoothed upon both sides, and sandpapered upon the inner sides before being put together; the outer sides of these pieces may be sandpapered better after they are nailed together. The grooves in the ends for the partition should be cut before the pieces are sandpapered on the inner side.

Glue should be used *sparingly* on the joints of the rim, so as not to be squeezed into the inside of the box, thereby causing unnecessary work in cleaning it off. The bottom should be made square, and of a size to project beyond the rim $\frac{1}{2}$ " upon all sides, after which the corner should be chamfered as indicated, or rounded to a true quarter round. If the latter form is adopted, care should be used that the curve does

not extend upon the top of the bottom far enough to prevent the rim of the box from fitting.

C. Fitting the rim to the bottom: In order to insure that the joint between the bottom of the rim and the bottom of the box is as nearly perfect as possible, the inside of the bottom of the rim should be planed under a little. This may be accomplished by resting the plane upon two sides of the box rim, and making the stroke as shown in Fig. 160, the iron cutting between its center and the outside of the face of the plane. This will allow the middle of the iron to cut upon the inside of the box more than upon the outside, thus "cutting under," and making the outside of the box fit the bottom closely where it is the most conspicuous.

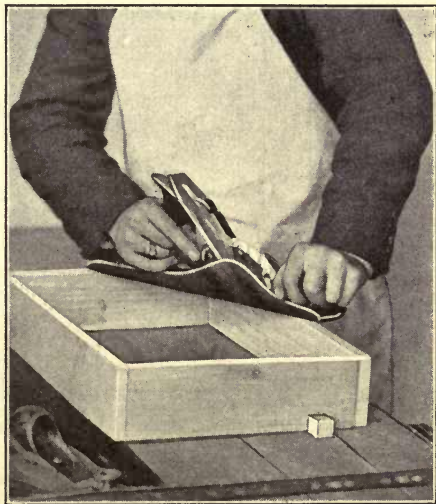


FIG. 160. — PLANING THE EDGE OF A BOX TO FIT THE BOTTOM.

D. The partition and handle. The partition, *b*, Fig. 159, should be smoothed and sandpapered and put in its place and nailed; and the round

handle, *e*, prepared and fastened by $\frac{1}{4}$ " dowels, which should be thoroughly glued and wedged, as at *h*, to prevent the handle from being pulled off. Be sure that the wedges are driven at right angles with the grain, or they may split the handle. Extreme care should be exercised not to bore the holes which are to receive the dowels through the sides of the partition at *j*. Long, slender, round-headed screws may be used instead of the $\frac{1}{4}$ " dowels, if desired.

E. Nailing: In nailing the box together, $1\frac{1}{4}$ " brads should be used, which should be driven both ways of the joint, as shown at *k*, Fig. 159. Do not use common nails, as they should be used only upon the roughest work, and where the greatest strength is necessary.

F. Nails: The nails used by carpenters, illustrated in Fig. 161, are of four different kinds, as follows:—

Common nails, *A*, which range in size from 3*d* (3 penny) to 60*d* box nails, other nails for common use being generally of this type.

Finish nails, *B*, which range in size from 6*d* to 10*d*, and are used for moldings, picture frames, and other places where it is required that

the nails should be as nearly invisible as possible. This shape of head may be set beneath the surface with the least danger of splitting the wood. The smaller sizes of this type of nail are called brads, or sprigs, and range in sizes from $\frac{3}{8}$ " to $1\frac{1}{2}$ " and are of different sizes of wire.

Casing nails, *C*, used for fastening casings, or inside finish, though the finish nails are often used for this purpose. The heads of these nails are supposed to enter the wood without tearing it, making only a clean round hole.

Flooring nails, *D*, the most essential difference between this type of nail and the finish or casing nail being the size of wire from which it is made,

which will, in most cases, allow the nail to be driven into moderately hard wood without the necessity of boring a hole for each nail.

85. Bookshelf. Fig. 162.

Material: 2 ends, $18\frac{3}{4}" \times 6" \times \frac{5}{8}"$.

2 shelves, $23\frac{1}{4}" \times 5\frac{3}{8}" \times \frac{5}{8}"$.

1 back, $23\frac{1}{2}" \times 6" \times \frac{1}{2}"$.

1 back, $23\frac{1}{4}" \times 4" \times \frac{1}{2}"$.

Construction of model: The ends of the bookcase should be grooved or housed, as at *f*, to receive the shelves, the length of which should be $\frac{3}{4}$ " less than the outside length of the case, to allow for the depth of the groove. These grooves should be laid out by knife marks, and to insure their fitting the shelves closely, should be made a little less in width than the thickness of the shelves which enter them, just as the cuts in a halved joint are made smaller than the pieces that go into them. Attention is called to the horizontal section *aa*, which shows that the groove is stopped $\frac{1}{2}$ " from the face edge of the end, and that the shelf is notched $\frac{7}{16}"$, as at *g*, so as to prevent the groove from showing on the front edge of the end, as it would if it were cut through. The

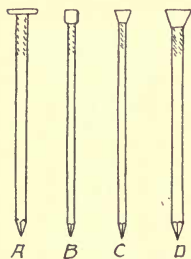


FIG. 161.

A, Common nail.

B, Finish nail, or brad.

C, Casing nail.

D, Flooring nail.

shoulder cuts, or the cuts across the face edges of the shelves, should be made upon all the shelves at once, clamping the pieces together for that purpose. The distance between them should be carefully calculated so as to make each shoulder about $\frac{1}{16}$ " less than the extreme length of the shelves; this will allow the ends of the shelves, beyond the shoulders, which fit into the grooves of the ends of the case, to be a little less than the depth of the grooves, as at *h*, thus insuring a good joint at *c* and *g*,

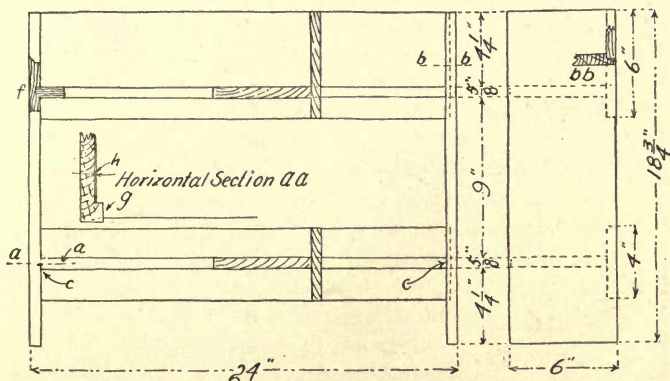


FIG. 162. — BOOKSHELF.

at each end of the shelf. The depth of the shoulder should be about $\frac{7}{16}$ ". This is the most important joint of the case, and the fitting should be done carefully, as a poor joint at *c* will be in the most conspicuous place.

The face edges of the shelves should set back from the face edges of the ends about $\frac{1}{8}$ ", as it is an almost invariable custom that two pieces should not be finished flush in work of this sort. This, to some extent, hides an imperfect joint, if one is made, or any opening after the work is finished.

The backs should be fitted into a rabbet made in the back of the ends, as shown by the section *b b*. Any suggestion of the shape of the ends is purposely omitted, as the student should make his own design, being governed by the advice of the teacher.

This model may be finished in the natural wood with shellac, well rubbed down, or may receive a dark stain and a wax finish.

86. **Drawing board.** Fig. 163. (See Handbook: Fig. 39.)

Material: 6 pieces, $25'' \times 3\frac{1}{4}''$ (about) $\times \frac{5}{8}''$.

2 cleats, $19'' \times \frac{5}{8}''$.

18 F.H.B. screws, 1'' No. 9.

A. Gluing a wide board: This is an exercise in gluing up a board so that the effect of the tendency to warp will be minimized, which may be accomplished by so placing narrow pieces that the concave and convex sides of the annual rings will alternate in forming the surface of the

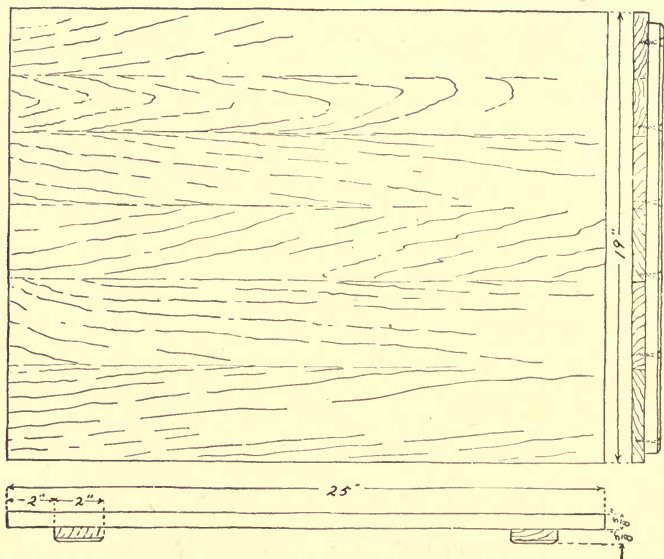


FIG. 163. — DRAWING BOARD.

board. These sides may be determined by examining the annual rings of the boards, which may be seen at either end. As the tendency of a board is to warp with its concave side toward the outside of the tree, the warp of each narrow piece will offset that of those which join it. (See Fig. 8, "Elements of Woodwork.") The joints should be carefully fitted and doweled; see Topic 69, Method 1.

B. Cleating across the grain: The cleats should be screwed upon the back as shown; the holes for the screws being slotted by boring two

holes beside each other, parallel with the grain, which will allow the screws to move a little back and forth as the board shrinks and swells.

A cleat should never be glued across the grain, as when the board begins to shrink, the glue will not allow it to do so, and the result will be that the joints will open, or the board will warp and twist badly. The cleat may be glued in the center for two or three inches, if desired, though this is not at all necessary; but it allows the board to shrink from the edges to the middle, and the screw holes being slotted, will permit this movement to take place without its surface or shape being affected.

C. Squaring the board: The ends of the board should be jointed perfectly straight, and square with the face and sides of the board, so that the T square will move accurately upon either end, or edge.

D. The surface of a drawing board: After the board is carefully straightened and smoothed, it should be sandpapered diagonally from each corner, and finished parallel with the grain. It needs no finish aside from the sandpapering.

87. T Square. Fig. 164. (*See Handbook: Fig. 40.*)

Material: 1 tongue, $28'' \times 1\frac{3}{4}'' \times \frac{1}{8}''$.

1 head, $10'' \times 2\frac{1}{4}'' \times \frac{3}{8}''$.

5 brass screws, $\frac{3}{8}''$ No. 3.

Maple, cherry, or any close-grained, well-seasoned wood, may be used in making this model. The pieces may be glued up of any dark wood

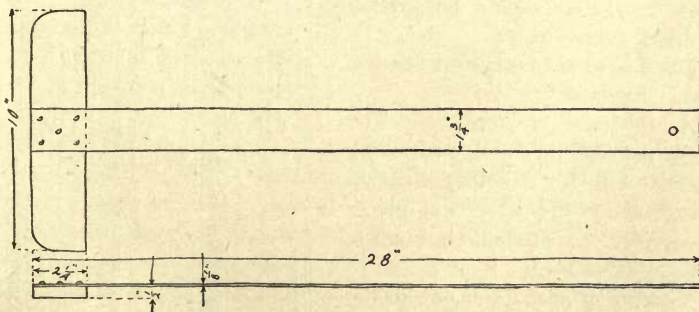


FIG. 164. — T SQUARE.

edged with maple or white holly, but it is not necessary except that it makes a better looking job. If the gluing is well done, however, a piece of glued-up work will hold its shape better than if made of one piece.

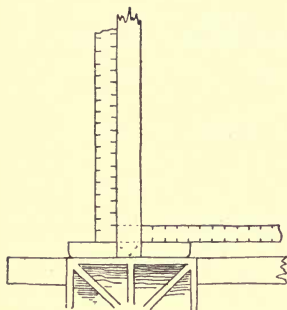


FIG. 165. — FASTENING THE TONGUE AND THE HEAD.

A. Accuracy of the model: This model requires that the utmost care should be exercised at each step, for unless the completed model is absolutely accurate, it is worthless. Straighten one edge of the tongue carefully, after which the other edge should be made perfectly parallel. The head may be of any desired shape.

The tongue should be fastened to the head of the square by means of small screws and glue. Use glue sparingly, and place both pieces in a vise, as shown in Fig. 165, applying a gentle pressure at first. Set the tongue in its exact relation with the head, placing a steel square, as indicated, to insure accuracy. Set up the vise to furnish sufficient pressure to hold the pieces firmly while putting in the first two or three screws, after which a handscrew may be put over the screws already in place, and the square removed from the vise, while the rest of the screws are being driven. Lay the square away for the glue to set, with handscrews so placed as to impart an equal pressure on all parts of the joint.

For finishing the model, two thin coats of shellac should be applied and well rubbed down.

88. Threefold screen frame. Oak. Fig. 166.

A. Omission of stock list: The stock list for this and succeeding models will be omitted, mention being made simply of the pieces necessary, the student estimating their dimensions.

Sequence of work: Get out all the pieces except the panels *b*, and the beads *h*, which hold the panels in place to their exact dimensions. The stiles should be planed square upon their inside edge; that is, the

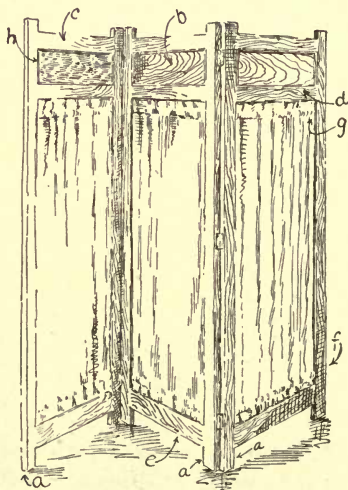


FIG. 166. — THREEFOLD SCREEN.

edge against which the shoulders of the tenons fit. Work from the face side, and leave the stiles the full width to which the piece has been roughly cut (without planing the other edge) and an inch or more longer than desired, as this extra wood may be needed before the screens are finished.

Cut off the top rails, *c*, the middle rails, *d*, and the bottom rails, *e*, 2" longer than the desired distance between the stiles, because the tenons on each end will enter the mortise in the stiles, 1". Mark all the shoulders on these rails at once, allowing exactly the same distance between, that it is desired that the stiles shall be apart; mark each separately, and square carefully around all sides with a distinct knife mark, working always from the face side and edge.

B. Laying out mortises and tenons: The stiles should now be placed side by side, inside edges up, as in Fig. 167. Across the inside edges of all the stiles draw pencil lines square with the sides, as at *b*, indicating the exact location and length of the mortises. With a mortise gauge set to make the marks for a $\frac{1}{4}$ " mortise, mark all the mortises in the stiles, and the tenons on the ends of all the rails, without changing the set of the gauge, working from the face side in every case. This is important.

With a $\frac{1}{4}$ " bit, bore one hole in the middle of the length of each mortise, and with a $\frac{1}{4}$ " chisel, cut out the mortise, cutting across the grain in every case, never parallel with it; be careful that neither the $\frac{1}{4}$ " hole nor the mortise goes through to the other edge of the stile.

C. Drapery rods: Bore a $\frac{3}{8}$ " hole, 1" deep, 1" to its center above the bottom rail, as at *f*, and the same distance below the middle rail, as at *g*, to receive the dowels or brass rods which support the drapery panels. Smooth and sandpaper the edges of the rails and stiles, except the outsides of the latter, but not the sides of any of the pieces.

D. Gluing: Glue the frames together, holding them in place by clamps, as in Fig. 168, which are used for the same purpose as hand-

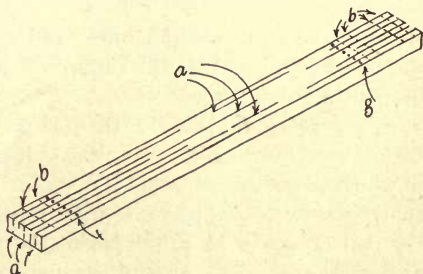


FIG. 167. — THREEFOLD SCREEN — MARKING FOR MORTISES.

screws upon work which is too large for the latter to reach. These should be placed exactly opposite each rail, so as to hold the frame square. If the frame is not perfectly square, move one clamp to a

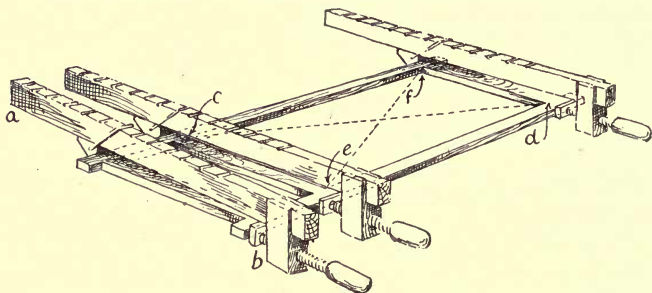


FIG. 168. — THREEFOLD SCREEN — GLUING AND SQUARING BY DIAGONALS.

slight angle, as at *ab*; this angle and its direction must be such that the pressure applied by the clamp will pull the frame square and hold it so until the glue sets.

E. Squaring the frames: Do not use a square to test the frame, because the clamp may spring the stile out of a perfectly straight line, in which case a square would be useless. Use a stick of suitable length, sharpened to a chisel point, to measure the diagonals *cd*, and *ef*. Place the point of the stick in the angle at *d*, and make a pencil mark at *c*; change the stick to *ef* and compare *cd* and *ef*. By swinging the clamp as described above, make the diagonals the same length, if the first measurements do not coincide.

After the glue has set, joint the edges of the stiles square and to the desired width. Smooth and scrape both sides of the frame. If strap hinges, as shown in Fig. 170, are to be used, round the edges as shown at *e*, Fig. 169, and sandpaper thoroughly.

F. Beads and panels: Prepare, miter, and fasten in place upon one side of the frame the small beads shown at *f*, Fig. 169. These should



FIG. 169. — THREEFOLD SCREEN
— SECTION OF STILES FOR
FLY HINGE.

be made flush with one face of the frame, leaving those of the other side loose. They may be made with a bead plane, which makes a molding shaped like those indicated, or the pieces may be rounded by hand, though any small

molding may be used which does not project beyond the face of the frame, in which case the screen cannot be folded together. Cut the panels, *g*, to the correct size; smooth, scrape, and sandpaper them; then remove the loose beads, put the panels in place, and fasten the other beads, which will hold the panel securely.

G. Finish and hinges: Stain, fill, and finish the screen to suit taste. Prepare twelve strips of thin sheet brass or rawhide, say $3'' \times 1''$, for hinges, and put them on as shown in Fig. 170, using brass tacks with a very flat round head, so that they will not mar the face of the screen which is folded against them. This makes a satisfactory screen hinge, as it allows the screen to be opened either way; two of the strips make one hinge, and three hinges are necessary for each joint. An ordinary hinge may be used, in which case the stiles should be left square. Hinges of this sort will allow the screen to swing but one way.

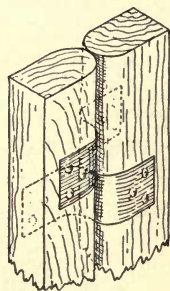


FIG. 170.—THREE-FOLD SCREEN—THE FLY HINGE.

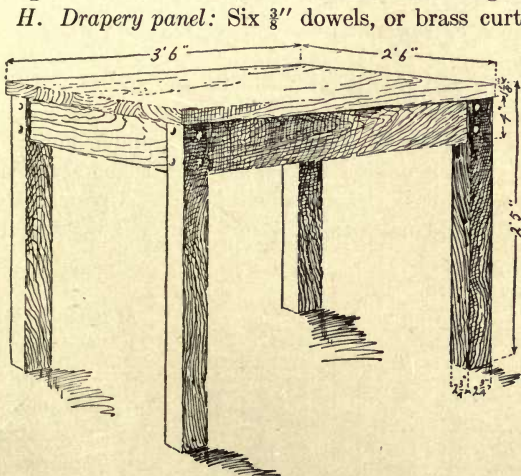


FIG. 171.—LIBRARY TABLE.

(The construction of this table is fully explained in Figs. 45 and 46 of the Handbook of this series.)

made the right length to enter the holes which were bored to receive them; these are to hold the drapery which forms the large panel of the screens. The drapery should then be adjusted on the rods and the latter sprung into position.

89. Library table. Fig. 171.

Get out the stock list. From the dimensions upon it, cut the tapered legs and the rails. Make the table leg joint, smooth and sand-paper the members, and glue them together. In cutting the material for the top, the appearance of thickness may be secured without the expense or the weight of using thick stock, as follows: Cut the top from $\frac{7}{8}$ " stock, and glue it up in the ordinary way, making a doweled glue joint. Cut the top to its required size roughly, and straighten the under side across the ends by traverse planing. Glue pieces about 5" wide and as long as the top on the under side of the top, flush with the edges. Cut pieces 5" long, and wide enough to fill in be-

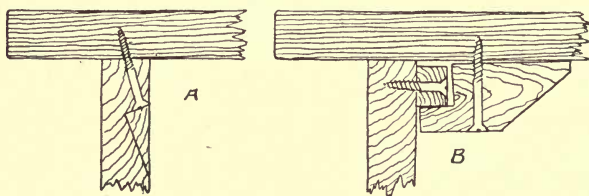


FIG. 172.—METHOD OF FASTENING THE TOP OF TABLE TO RAILS.

tween these edge pieces, and glue them flush with the end of the top. The whole may now be treated as though the entire top were made of thick material. Fasten the top on by one of the methods indicated at A or B, Fig. 172. If it is desired to make a more elaborate table, the construction need not be essentially different. Upon a table of this size, the top should not project more than $1\frac{1}{2}$ " beyond the legs.

90. Mission piano bench. Fig. 173.

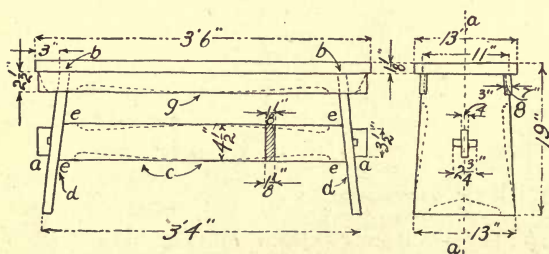


FIG. 173.—PIANO BENCH.

Material: Oak.

1. *Sequence of work:* Prepare the rectangular pieces with which the standards, *d*, and the stretcher, *c*, are to be cut. Locate the tenons upon the ends of

the stretcher, and the mortises in the standards, before the pieces are cut to their desired shape, as it is much more convenient to work from the face edge of a rectangular piece than from the center line, *aa*, which would be necessary if the standards were made as designed.

2. Cut and fit the shoulders and tenons of the stretcher, and the mortises of the standards, to each other, using care that the shoulders, *e*, of the stretcher, and the tops and bottoms of the mortises are made at the correct angle. To guard against the tendency to cut the mortises so large that the tenons will not fill them, the student should make a very close fit, in anticipation of trimming, if necessary, when the pieces are fitted together. The mortises should be bored out as much as possible to avoid the liability of splitting the standard while using the chisel and mallet. The mortises should be cut under on all sides, as indicated at *g*, Fig. 174, in order to insure a perfect fit upon the surface.

3. Design the contour of the standards, stretcher, and side rails, and work out their forms carefully, using a wood rasp or file, taking care not to chip off pieces from the back side. If this should happen, save the pieces and glue them back in their places.

4. The top and the bottom of the wedge must be parallel, and when it is in place, the outside should be plumb, and the inside planed to fit the angle of the standard, and wedged, or tapered, about $\frac{1}{8}$ " for each inch in its length. The wedges should be made considerably longer than necessary, so that they may be driven as they are fitted, and not cut to length until the foot rest is ready to be set up permanently.

5. Smooth, scrape, and sandpaper the standards and stretcher.

6. Fit the side rails in their places, halving them into the tops of the standards by the same method used in fitting the top rails of the foot rest of Topic 83. Their top edges should not be less than $\frac{1}{4}$ " from the tops of the standards, so that the latter may enter the groove cut for them in the under side of the top.

7. At *b*, Fig. 174, is shown the method of fitting the top to the

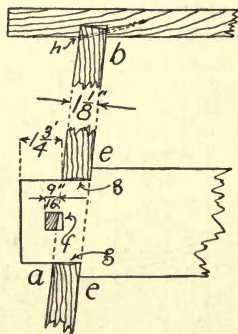


FIG. 174. — PIANO BENCH
— SECTION SHOWING
CONSTRUCTION AT *a*,
FIG. 173.

standards; at *a* is shown the method by which the stretcher is fitted. The space at *f* is for the purpose of allowing the stretcher to be pulled to a joint by the wedge.

8. Prepare the top, cutting the grooves in it for the ends of the standards. Smooth, scrape, and sandpaper it and fasten it on with glue, and with nails driven as shown at *h*.

9. Stain and finish to suit taste.

91. Medicine cabinet. Fig. 175.

Material: Poplar (Whitewood).

In making this model, the top, bottom, and two sides should be made first; and the rabbet, shown at *a*, should be cut before the pieces are

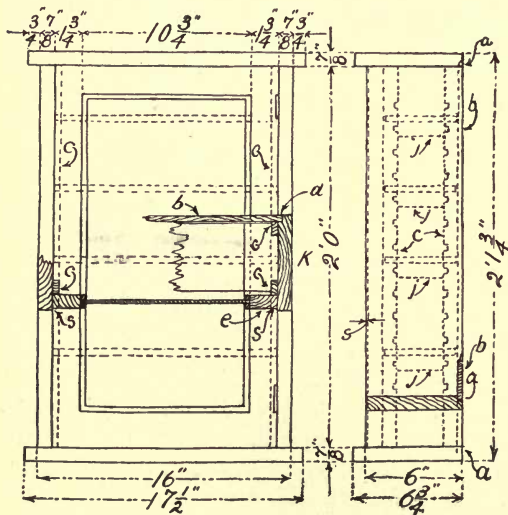


FIG. 175. MEDICINE CLOSET.

nailed together, stopping the rabbet in the top and bottom at nearly the place where it will intersect with the rabbet *d* of the sides, so that when the case is nailed together, the back, *b*, will fit into both rabbets. The location and use of the various pieces will be seen by a careful study of the sections.

A. Movable shelves:
In preparing the ratchets, *c*, which allow the shelves to

be placed where wanted, cut a $\frac{7}{8}$ " piece the same length as the sides of the case, and wide enough to allow all of them to be cut from it, say 21". With a sharp knife, lay out the cuts, *d*, across the piece, as shown at *A*, Fig. 176, marking their depth with a gauge. Make the cuts with a backsaw, and remove the wood between them with a narrow chisel. With a sharp rip saw, cut the pieces as indicated by dotted lines, *e*, and plane them down to $\frac{3}{8}$ " or $\frac{5}{16}$ " uniform thick-

ness. Allow wood enough to insure that there will be little danger of planing them too thin. The ratchets, *c*, Fig. 175, are placed against the back, *b*; and the door stile, *e*, as indicated at the section of the side, at *K*. The cleats, *j*, are cut between the ratchets, *c*. Cut these from a piece about 4" wide, as indicated at *F*, Fig. 176, the seven dotted lines showing where the pieces should be ripped, after the ends, *t*, *t*, have been cut. They should then be planed to the same thickness as the ratchets, *c*.

B. The door: The pieces for the door should be about $\frac{1}{8}$ " wider than needed, to allow the door to be planed to a fit after it has been

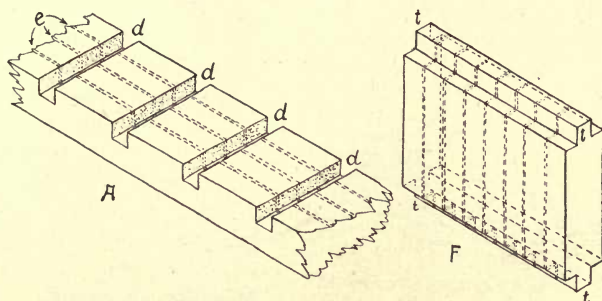


FIG. 176. — MEDICINE CLOSET DETAILS.

A, Method of cutting ratchets. *F*, Method of cutting cleats.

made. The stiles, especially, should be longer than needed, so that they may be sawed off after the door is glued up. The door may be either doweled or mortised together, and the glass or wood panel held in by the same method as in the screen. See Fig. 169.

C. Accuracy of case and door: Care must be used, in setting up the case and the door, to have them both square and out of wind; the latter may be proved by sighting across them. If the faces of the two stiles of the door coincide, and the front edges of the sides of the case appear the same, they will be all right.

D. Fitting the door: The door should be carefully fitted so that it will fall back of the front edge of the sides, or have a sinkage of about $\frac{1}{8}$ ", as shown at *s*, Fig. 175, as nothing of this sort should be finished flush.

E. The hinges: In cutting in hinges, the gauge is an indispensable tool, as a high degree of accuracy is necessary if even fairly satisfactory

results are desired. They may be cut half into the door and half into the side of the case, though upon ordinary work of this nature, they are usually cut entirely into the door. Whichever method is used, the hinges should be fitted carefully against the wood. In this instance, there is an advantage in cutting them by the latter method, as more wood is obtained for the screw in the side, thus permitting a longer screw to be used.

The top of the top hinge should be placed opposite the bottom of the top rail, and the bottom of the bottom hinge should be placed at the top of the bottom rail, and both set so that about two thirds of the round of the hinge will project beyond the face of the door. A pair of $1\frac{1}{2}$ " butts will be suitable; they should be fastened on with $\frac{3}{4}$ " screws,

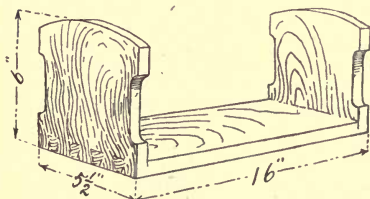


FIG. 177. — DOVETAILED BOOKRACK.

which should be of a size to allow their heads to be driven flush with the inside of the hinge.

Finish in the natural wood with shellac, or stain and wax to suit taste.

92. Dovetailed bookrack. Fig. 177. (See Handbook: Fig. 41.)

Material: Oak or Poplar.

Dovetail the pieces together as shown in the sketch; if the design shown is used, be sure that the curves are symmetrical. It is better, however, that the student make an original design for the end. When the model has been glued, and set away to harden, be sure that the ends stand square with the bottom. See Fig. 78, A.

This model may be given a shellac finish, or stained and finished in wax.

93. Magazine stand. Fig. 178.

Material: Oak.

The ends: Lay out and cut the curves of each end. Prepare the top and bottom shelves. Mark the tenons, or tusks, upon them, and the corresponding mortises in the ends, following the same methods as in Topic 90, except that the work should be from a center line, instead of from a straight edge.

The shelves: The mortises and the grooves, or housings, for the top and bottom shelves should be cut in the ends, and the shelves fitted before the grooves are made for the middle shelves. All the shelves

should be cut with the shoulders as at *g*, Fig. 162, except that the face of the shoulders should be at the same angle as the flare of the sides, as at *a*, Fig. 178. The student should be careful that the shoulder bevel is in the right direction at each corner of the shelves. The shelves should each be about $\frac{1}{8}$ " narrower than the width of the end of the case at the groove, so that they will not finish flush.

In fitting the middle shelves, the ends and the top and bottom shelves should be set up temporarily, and the wedges fitted as upon the piano bench, care being taken not to cut the wedges off until the case is ready to set up permanently. While the case is in this stage, locate the middle shelves and ascertain their length, taking the measurements at exactly the places they are to occupy.

Setting up the case: In setting up the case, both sides should have the same pitch

inward, though if the mortises of the top and bottom shelves have been made accurately, this will take care of itself. The joints of the shelves should be held in place by clamps while the glue is setting; $1\frac{1}{2}$ " brads should be driven through all the shelves into the ends, as shown at *b*, Fig. 178.

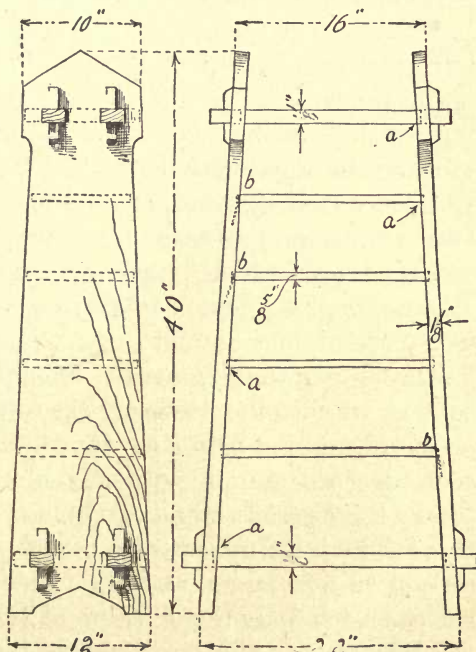


FIG. 178. — MAGAZINE STAND.

94. **Wood finishing.** — In the following brief treatment of wood finishing will be found suggestions regarding

methods and processes which may be applied in finishing the models of this chapter. The workman may mix his own fillers, stains, etc., but he will generally find it easier and more satisfactory to purchase such material, made by some responsible manufacturer.

Filling: After the model has been completed, it should be made ready for the finish by filling the grain. If an open-grained wood similar to oak is to receive a shellac finish, it should first be well filled, after which as good a job may be done with two or three coats of shellac as with six or more without the filling. Filling is made in two forms: the paste, for use upon open-grained woods, and the liquid, which is intended for use upon such woods as pine, poplar, cherry, maple, etc., and which will take the place of one or more coats of the more expensive finish. Both these may be bought ready mixed, and colored to suit the taste by the addition of dry colors; or the paste may be mixed, by combining either whiting, silex, or corn starch, with any dry colors necessary to secure the desired color. To hold or bind these together, they should be mixed with equal quantities of boiled linseed oil and japan, and the whole thinned to a working consistency by the addition of turpentine, benzine, or gasoline, though the paste should be as thick as is practicable with its spreading well.

Filling need not be spread very smoothly, but the surface of the wood should be covered, and the filling thoroughly worked into the grain. It should then be allowed to stand a few minutes until the filler has become powdery, and seems to stick to the wood when rubbed with the finger. It may then be rubbed off with soft shavings or excelsior, the rubbing crossing the grain when-

ever possible. Finish it with a soft cloth. The inside corners should be cleaned out with a sharp-pointed stick. Allow the work to stand several hours or overnight before the finish is applied; otherwise the moisture in the filling may cause the finish to blister. Liquid filling should be spread as smoothly and evenly as possible, or the laps will be apt to show when the finish is spread over it.

95. Stains. — Stains of almost any desired color and composition may be purchased, but in the following paragraphs an endeavor is made to explain the composition of a few stains which may be easily made by any one.

In finishing open-grained woods, the wood is often stained and then filled, as it is thereby colored more evenly; but upon general work, it is the custom to color the filling only. *Stains for close-grained woods* may be made by mixing dry colors with turpentine, boiled oil, and japan, — the same combination as the filler, except that the whiting is not used. A stain should be applied in the same way as a filler, but not allowed to become so hard before being wiped off, or there will be light places in the finish; these will also result if it is rubbed too hard in spots.

A cherry stain may be made by mixing Venetian red with rose pink. For mahogany, add a little carmine. Burnt umber makes a fairly good black walnut stain, but it is improved by adding a little burnt sienna. Asphaltum, thinned to the desired color, makes a good and convenient black walnut stain.

Equal parts of permanganate of potash and sulphate of magnesia, dissolved in water, will make a rich brown stain, though it will after several years fade to a light brown. Better results may be obtained if the stain is

applied hot. Verdigris and indigo, mixed in hot vinegar, makes a good green; several coats may be necessary. Apply hot. A solution of logwood and sulphate of iron will make a good brownish black. This should also be applied hot.

96. Shellac. — Shellac may be bought ready mixed, or may be cut by dissolving the gum in wood alcohol. In applying shellac finish, the wood should be first filled or stained; upon this, one coat is laid after another, each being rubbed down with pulverized pumice stone or No. 00 sandpaper, after which the next coat is spread. Upon ordinary work, two or three coats are usually sufficient, the last coat being rubbed down with sandpaper and oil, or with pumice stone and oil, after which it may be polished with a soft cloth. If a dead finish is desired, the final rubbing should be done with water instead of oil. Shellac should be laid in thin coats, since, if applied thickly, it will pit badly in drying, and make trouble in rubbing. Use the brush with quick strokes, never working over a place already covered, as a muddy place will result.

97. Wax finish. — Wax finish may be used in almost any place in which shellac is suitable, though it gives more satisfactory results upon dark wood than upon wood of a light color. It may be purchased, as there are many good finishes of this sort upon the market. They are made from a secret formula, and their only point of superiority over the homemade finish described here, is that they harden more quickly. The following homemade wax finish is easy to make, economical, and satisfactory. Dissolve as much pulverized rosin as may be picked up on a cent in a half pint of turpentine, which

should be heated over a slow fire, in a water or steam double vessel. Allow it to simmer until it is clear, then add a piece of beeswax as large as a thimble, which should be cut into shavings, and let the mixture continue to simmer slowly until it becomes clear, when it is ready for use. This should be applied hot, with a brush, and, when dry, should be polished with a soft cloth; this may be done as often as required, each time being an improvement.

A dark floor may receive this treatment as often as may be necessary.

98. Brushes.—For stain and filling, a cheap brush of any suitable size will do, a flat brush generally being used upon ordinary work. For shellac and varnish, a fine brush will give better results than a coarse one; usually, however, it is the best practice to use as large a brush as the nature of the work will permit, as it will hold more and therefore cover more surface and show fewer laps. Brushes from $1\frac{1}{2}$ " to 2" in width will be found satisfactory for the work of pupils and amateurs.

The care of brushes is an important part of the work of those who use them, as neglect or carelessness may destroy a valuable brush overnight. Unless a brush is to be used again soon, it should be thoroughly cleaned. In cleaning a stain, filling, paint, or varnish brush, use benzine or turpentine; but for a shellac brush, use wood alcohol, cleaning all the small particles off. To obtain the best results, all brushes should be washed in hot, soapy water, and thoroughly rinsed in clean water. Shellac and varnish brushes should not be changed from one to the other unless thoroughly cleaned. Never allow a brush to stand upon its side for more than a few min-

utes at a time, as a wrong direction is easily given the bristles, and a valuable brush may be quickly destroyed by a little carelessness or negligence.

Old brushes, well broken in and cared for, will give better results than new brushes; therefore they should be treated with every possible consideration.

SUGGESTIVE EXERCISES

79. How should a student review his previous work to assist in new work? What is the relation between the length and width of a board and its grain? Review processes of making a bench hook, and discuss other ways of obtaining the desired results.

80. Demonstrate the method of drawing a curve through points. How may the elbow be used to assist in drawing curves of certain dimensions? What should be guarded against in sawing a curve?

How should the spokeshave be used with reference to the grain?

In what cases should a wood file, or rasp, be used?

81. How should cuts be made to insure a perfect joint? What should be the relation of the bottom of a joint to its face?

Describe the method of doweling the top on the foot rest.

82. Should the bottom of a box be cut to its exact size before the rim is made? Why? How should the bottom of the rim of a box be planed to allow a perfect fit? Describe the different kinds of nails used by the carpenter.

83. How should grooves be laid out to insure a perfect fit? Should two pieces be finished flush? Why?

84. How may a wide board be glued up to minimize the tendency to warp? Should a cleat be glued the entire distance across the end of a board? Why?

85. Which holds its shape better, a solid piece, or a well glued-up piece?

86. How may pieces be worked in pairs? How may a piece of gluing be squared by manipulating the clamps? How should a piece of work similar to a screen frame be squared?

87. How may a table top be fastened on without nails or screws showing in its surface?

88. Describe method of laying out a mortise at an angle. What should be done with chips which break off?

89. How should ratchets be cut? Should a door be made exactly the desired size? In gluing up a door, what should be guarded against to insure that it will fit well? Should a door be hung flush with its frame?

90. Review dovetailing.

91. How should the lengths of the shelves of a magazine stand be ascertained?

92. Why is wood filler used? Describe filling and the process of spreading it.

93. What is the difference in the results between staining and filling together, and staining and filling alone?

How may stains be mixed and used?

94. Describe shellac finish. Should shellac be applied in thick or thin coats? Describe the process of rubbing down.

95. Describe wax finish. In what respect are the ready-mixed wax finishes superior to the homemade ones?

96. Describe the kinds of brushes adapted to different kinds of work. How should brushes be cared for?

CHAPTER V

ARITHMETIC QUESTIONS

1. Measure the distance from corner to corner between the windows of a given side of the shop, and give total distance in feet and inches.

2. Measure the bench top to the nearest inch (avoiding fractions), and give number of square feet and inches it contains.

3. How many square feet are there in a given blackboard?

4. How much should a gauge be set to make a mark in the middle of the edge of a $\frac{7}{8}$ " board?

5. If a gate $38\frac{1}{2}$ " wide is made of slats $2\frac{1}{2}$ " wide, and set 2" apart, what is the total width of the slats?

6. A man builds a barn $27' 9" \times 35' 6"$ in the middle of the short dimension of a lot which is $62' \times 135'$, and 20' from one end of the lot. If the short dimension of the barn is set the short way of the lot, how much land will there be on each side of the building?

7. How many square feet of land are left in the lot after the barn has been built?

8. Measure the width of the window openings in a given side of the shop, and give total amount in feet and inches.

9. Give total length of a given side of the shop.

10. Measure to the fraction of an inch the distance between two given benches.

11. If the entire top of a given bench were of uniform thickness, how many feet, board measure, would there be in it?

12. How many square inches of lighting surface are there in a given side of the shop?

13. If a tenon $\frac{1}{2}$ " thick is to go in the exact center of a piece of $1\frac{3}{4}$ " lumber, how much wood will be left on each side of it?

14. How many pieces $2\frac{3}{8}$ " wide will be necessary to fill closely a space $40\frac{3}{8}$ " wide?

15. Measure the distance from corner to corner, and between windows, of a given side of the shop, and give total length in feet and inches.

16. Measure the window openings of a given side of the shop, and give total area in feet and inches.

17. If a box is $8\frac{1}{4}'' \times 7'' \times 4''$ high, how many cubic inches of water will it contain?

18. What is the capacity of the above box in liquid measure?

19. If a board is 14' long and 15'' wide at one end and 12'' at the other, how many feet B. M. are there in it?

NOTE. — In practice, the terms sq. ft. and sq. in. are rarely used, as "sq." is omitted, but in measuring lumber it is always understood.

20. How many feet of $3\frac{1}{2}''$ flooring should be ordered to lay a floor $12' \times 16' 6''$, allowing $\frac{1}{4}$ of area for waste?

NOTE. — Hereafter, the words "of area" will be omitted, as they are never used in practice, it being always understood that any quantity denoting waste indicates the proportion of the actual area to be covered which must be allowed.

21. How many inches are there in a floor $17\frac{2}{3}' \times 19\frac{3}{4}'$?

22. How many feet are there in a floor $17\frac{2}{3}' \times 19\frac{3}{4}'$?

23. If a 2'' floor is laid in the above room, how many feet of flooring will have to be ordered, allowing $\frac{1}{4}$ waste?

24. A four-light window is $33'' \times 62''$. Allowing .233 of its entire area for the sash, what is the size of the glass?

25. If a mitered frame is to be made of molding $2\frac{1}{2}''$ wide, how much more than the given eight dimensions must be allowed to each piece, in order to estimate the exact length of molding required?

26. If the light area of a $14'' \times 28''$ glass is $\frac{3}{8}''$ less than the actual size of the glass, what is the total light area of a four-light window?

27. Measure a given end of the shop, and calculate the entire space, exclusive of openings.

28. What is the total of the door openings of a given end of the shop?

29. What is the sectional area of one of the posts in the shop, measuring to the nearest inch?

30. What is the area of the shop floor?

31. A lumber pile of 1'' lumber has 62 layers, averaging 4' in width. How many feet B. M. are there in the pile?

32. How many inches of lighting surface are there in a given side of the shop?

33. If one of the posts supporting the floor above is 12' long, how many feet B. M. are there in it?

34. How many cubic inches are contained in a box $16'' \times 11\frac{1}{4}'' \times 12''$ deep?

35. To what dry measure is the above box practically equivalent?

36. If a certain roof requires twenty $2'' \times 6''$ rafters 13' long, how many feet B. M. would have to be purchased?

NOTE.—Lumber carried in stock by lumber dealers is rarely of any other lengths than multiples of two, as the logs are cut in the woods to those lengths. Thus, if a piece is needed which cannot be cut from a 12' piece, a 14' piece will have to be purchased.

37. A floor is $15' \times 18'$. A carpet showing an 18'' border all around it is to be purchased. How many square yards will be necessary?

38. How many feet of flooring will have to be bought to lay the above floor, allowing $\frac{1}{4}$ waste?

39. If a house $28' \times 40'$ is to have for the cellar an excavation $\frac{1}{2}$ the size of the house and 4' deep, how many cubic yards of earth will have to be removed?

40. At $12\frac{1}{2}$ ¢ per cubic yard, how much will it cost to excavate the above cellar?

41. If a man sets and cases 4 door frames a day, at \$2.25 per day, how much will it cost to have him do this work upon a house having 31 door frames?

42. How many feet of flooring will it take to lay the floor of the shop in which the class meets, allowing $\frac{1}{4}$ waste?

43. If the lumber in a given wooden blackboard cost 4 ¢ per foot, what was the total cost if $\frac{1}{4}$ waste was allowed?

44. What is the light area of a $14'' \times 28''$ four-light window, if the glass is covered $\frac{1}{4}''$ all the way around by the sash?

45. How many feet are there in a pile containing twenty-four $\frac{1}{2}''$ boards, 14' long and 11'' wide?

NOTE.—Any thickness of lumber under 1'' is measured as 1'' thick. Lumber over 1'' in thickness is measured as 1'' plus the fractional parts of an inch. Thus, a $1\frac{1}{2}''$ plank is measured as $1\frac{1}{2}'$ of lumber per square foot of surface.

46. A glazed sash weighs 16 lb. What size of weights are necessary to hang it properly?

47. A cellar $20' \times 40'$ is to be dug; the excavation will be 2' deep

at one end and 6' deep at the other. At $12\frac{1}{2}$ ¢ per cubic yard, what will the excavation cost?

48. A and B receive 10 ¢ and 8 ¢ per hour, respectively. They take a contract for \$18.75, the material for which costs \$6.35. What will be the share of each?

49. If the material used in painting a given blackboard cost $1\frac{1}{3}$ ¢ per square foot, what was the total cost?

50. The labor upon a certain job cost \$4, which was furnished by A and B @ 8 ¢ per hour. C and D do the same job in 15 hr., @ $12\frac{1}{2}$ ¢ per hour. Which is the cheaper help? How much cheaper?

51. A table top is 10' long \times 3' wide, and $1\frac{3}{8}$ " thick. How many feet B. M. are there in it?

NOTE. — Lumber is sawed to stock thicknesses at the mill, and dressed lumber should always be estimated as being dressed from one of the stock thicknesses, generally the one $\frac{1}{8}$ " or $\frac{1}{4}$ " thicker than the dressed plank which is being figured. The thicknesses usually sawed are $\frac{3}{4}$ ", 1", $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", 2", $2\frac{1}{2}$ ", 3", etc. Thus, a $\frac{7}{8}$ " board is sawed from 1" stock, and $1\frac{1}{8}$ " is taken from $1\frac{1}{2}$ " plank.

52. A roof of $22\frac{1}{2}$ squares is to be shingled with shingles costing \$2.25 per M. If 4 lb. of nails @ 4 ¢ per pound are used per square, and labor costs 60 ¢ per square, what will the job cost?

NOTE. — A square is equivalent to a space 10' \times 10', or 100 sq. ft.

53. A timber 5" \times 9" \times 18' long contains how many feet B. M.?

54. How many nails should be purchased to lay the floor of this shop, if 4 lb. per square are used?

55. If the labor to lay the floor costs 75 ¢ per square, what will be the total labor cost?

56. Figuring to the nearest inch, how much space does a certain bench occupy upon the floor?

57. What is the total length of a given side of the shop?

58. A and B do a job in 12 hr., for which they receive \$2.40. How much did each receive per hour?

59. C and D receive 8 ¢ per hour to do the same job. How long ought it to take them to complete it?

60. Twelve bottles, 5" in diameter and 11" high, are to be packed for shipment. If they are packed in four rows of three each, and $\frac{3}{4}$ " is allowed all around for packing, how much lumber will be needed to make the box, allowing nothing for waste?

61. Make a stock list for the above box, denoting the use of each piece and giving the exact size.

NOTE. — The length of a piece of wood is always with the grain, regardless of the dimension the other way. Thus, it will be possible for a board to be much wider than it is long.

62. How many feet of flooring should be ordered to lay the floor in a hall $8' \times 22'$, with a stair opening $4' \times 14'$, allowing $\frac{1}{4}$ net area for waste?

63. After deducting the space occupied by benches, stock, and model cases, what is the aggregate area of the aisles of the shop?

64. A does a job @ 10¢ per hour, and receives \$1; B does the same job @ 8¢ per hour, and receives \$1.10. How much should A's pay be raised to equalize the cost of their work?

65. To what should B's pay be cut down to equalize the cost of their work?

66. How many feet B. M. should be ordered for a $5\frac{1}{2}'' \times 1\frac{3}{4}''$ door frame for a $2' 8'' \times 6' 8''$ door, allowing $\frac{1}{8}$ waste? Give answer to nearest even feet.

67. What is the weight upon the supports of a floor $20' \times 20'$, if the floor and joists weigh 18 lb. per square foot, and merchandise weighing $47\frac{3}{8}$ lb. per square foot is piled upon it?

68. How many feet of timber would have to be cut for a post $8'' \times 8''$ and $13' 6''$ long?

69. A and B contracted to build a blackboard containing 80 sq. ft. for \$10. Allowing $\frac{1}{4}$ waste, and estimating lumber @ 4¢ per foot, painting @ $1\frac{1}{2}$ ¢ per foot, labor at \$.06875 per foot, and the cost of other material at 75¢, did they make or lose, and how much?

70. A contracts to build a bookcase for \$3.25. The lumber costs him 65¢, other material 36¢, and he works 16 hr. on it. How much does he make an hour?

71. A board is 12' long and 7'' wide. How many feet B. M. does it contain?

72. A picket fence is to be built, 100' of which is on level ground; the rest goes over a mound which is 100' through from side to side at its base, and 30' high. Which part requires more pickets?

73. How many cubic feet are there in a room which is $12' \times 14' \times 9'$?

74. What will be the actual area of the section of a door jamb $5\frac{1}{2}'' \times 1\frac{3}{4}''$, with a $1\frac{1}{2}'' \times \frac{1}{2}''$ rebate taken out?

75. From a pile containing 2976' of lumber, 536' was taken and used for ceiling; the remainder was stuck into flooring and sold for \$40 per M. What did the flooring bring?

76. The above 536' was made into ceiling and sold @ \$35 per M. Allowing $\frac{1}{4}$ waste, how much surface would it cover, and what would it bring?

77. The above entire pile was bought for \$22 per M. It cost \$1 per M for stacking; \$4.50 per M for handling and kiln-drying; \$6 per M for sticking into ceiling and flooring. Did the dealer make or lose, and how much?

78. A journeyman mechanic, receiving 25 ¢ per hour, cuts up 100' of lumber in one hour; an apprentice, @ 8 ¢ per hour, cuts up the same amount in the same time, but wastes 18'. With lumber @ 4 ¢ per foot, which would be the more profitable man for the employer, and how much would he save upon each hour's work?

79. A box is 6' long, 2' wide, and 12" high, inside dimensions, is to be built of 1" boards, with the solid top and bottom put on with the grain running crossways. Make a stock list, showing the use and dimension of each piece.

80. Tell exactly how many feet of lumber there are in the above box, making no allowance for waste.

81. A board is 14' long, 9" wide. How many feet B. M. are there in it?

82. A board is 16' long, 19" wide. How many feet B. M. are there in it?

83. A bottom sash is 31" high. The top of each pulley is 54" from the stool. The cord extends from the top down upon the sash 14". Allowing 6" for knots at the ends, and 6" for weight to hang from the top of the pulley, how long will the cord be?

84. The sash weight of the above window is 14" long. If the sash slides upward 30", how far will the bottom of the weight be from the stool?

85. If the above sash weighs 14 lb., how many and what weights are necessary to hang the window?

NOTE.—A window as described above consists of two sashes.

86. How much siding will be necessary to side a house $32' \times 40' \times 18'$ high, if there are 24 window openings $3' \times 7'$ and 4 door openings $3' 6'' \times 8'$, allowing $\frac{1}{4}$ of the net area for waste?

87. A board is 10' long and 16'' wide. How many feet are there in it?

88. A board is 18' long and 7'' wide. How many feet are there in it?

89. A plank is 16' long, 14'' wide, and 2'' thick. How many feet B. M. are there in it?

90. A took a contract to build a desk for \$17.50. He hired B and C to help him, paying them 10¢ and 8¢ per hour, respectively. A worked 24 hr., and B and C 20 hr. each. The material cost \$6.75. What was A's share?

91. What did B and C each receive?

92. A pitch roof is 24' long, with rafters set 2' to centers. How many rafters are there in the roof?

93. If the above rafters are 2'' \times 6'' \times 15' long, how many feet will have to be ordered to furnish them?

NOTE.—In ordering framing material of the above nature, it is customary to order the number of pieces needed; thus the waste will be the difference between the neat length and the length purchased.

94. A table top is 6' 4½'' long, 3' 2'' wide, and 1¼'' thick. How much surface has it?

95. Allowing ¼ waste, how much lumber was cut in getting the stock out for the above table top? Give measurement to the nearest foot.

96. Students A and B receive the same pay, and are given a job together, with A as foreman, who does ⅔ of the work, as B shirks his share. A, as foreman, gets credit for doing only ½ of the work. What is his duty as foreman? What is his duty to himself, and his financial loss?

97. A board is 14'' long and 21'' wide. How many feet are there in it?

NOTE.—Anything less than 1'' in thickness is usually called a board; anything over 1'', a plank. Where no thickness is given, 1'' is assumed.

98. A plank is 12' long, 9'' wide, and 1¼'' thick. How many feet are there in it?

99. A plank is 14' long, 19'' wide, and 1½'' thick. How many feet are there in it?

100. A board is 12' long, 15'' wide, and ¾'' thick. How many feet are there in it?

101. How many shingles laid 4½'' to the weather will be needed to cover a pitch roof which is 50' long, with rafters 14' in length?

NOTE.—Shingles are generally put up in bundles of 200, 250, or 500; 1000 shingles means the equivalent of 1000 shingles 4" wide, though the shingles may be of any width; if the bales are full, they will measure 4000" in width per M. As about 25 per cent are thrown out, or wasted at the hips and valleys, it is customary to figure that 1000 shingles will cover a square if laid $4\frac{1}{2}$ " to the weather. As this is an average exposure, these quantities are usually figured as suiting nearly all pitches and exposures.

102. If 1000 shingles were all perfect and all laid $4\frac{1}{2}$ " to the weather, with no waste, how much surface would they cover?

103. A, B, and C divide equally the money they receive for doing a job which requires 12 hours' work from each. Their usual pay is 9 ¢ per hour, but in this case it was increased $\frac{1}{4}$. How much did each receive?

104. If an irregularly shaped room is 50' upon one side, 20' upon another, and 15' upon each of the others, how many feet B. M. will be necessary to cover the floor, allowing $\frac{1}{4}$ waste?

105. If a person, standing, occupies a space $20'' \times 20''$, how many people can stand in a hall which is $60' \times 90'$?

106. A scantling is $2'' \times 6'' \times 14'$. How many feet B. M. has it?

107. A scantling is $2'' \times 4'' \times 16'$. How many feet B. M. has it?

108. A joist is $2'' \times 8'' \times 16'$. How many feet B. M. has it?

109. Measure the sight of glass of the windows of a given side of the shop, and give total width of the sight of each window.

110. If a man lays 4 squares of floor a day, how long will it take him to lay a floor $75' \times 160'$?

111. The rafters of a pitch roof are 14' long, and the roof is 28' long. How many shingles will it take to cover it?

112. Allowing 4 lb. of nails per M, how many nails will it take to lay the above roof?

113. How much will it cost to lay the above roof, if the shingles cost \$2 per M and the nails $3\frac{1}{2}$ ¢ per pound, and if the work is done by a man who lays 2000 shingles a day and receives \$2 per day for his labor?

114. If a door is $2' 8'' \times 6' 8''$, and a rebate of $\frac{1}{2}$ " is allowed for the top and two sides, how many square feet are there in the opening?

115. Give total widths of the glass of the windows of a given side of the shop.

116. Give total width of the windows of a given side of the shop between stop beads.

117. How much wider is the sash than the total width of the glass?

118. If A receives 8¢ per hour, and B 7¢, how much does each make on a job for which they receive the total sum of \$13.50? The stock costs \$4.50, and they each work the same number of hours.

119. How many square feet of siding will it take to cover one side of a barn 40' long \times 18' high, allowing $\frac{1}{4}$ waste?

120. It takes a student 36 hr. to do a piece of work. If he spends $1\frac{1}{2}$ hr. a day, how many days will it take him to finish it?

121. A board fence 8' high is to surround a piece of land 60' \times 100'. How many feet of lumber will it take, if two 2" \times 6" rails are used? Give itemized answer.

122. Allowing a space of 8 sq. ft. to each person for aisles, etc., how many people can be seated upon a floor 60' \times 90'?

123. Allowing 20 lb. per square foot for a dead load, and 150 lb. for each person present, as in question 122, what weight do the walls of the building have to carry?

124. Measure a piece of furniture for a packing box, allowing $\frac{3}{4}$ " in length, width, and height for packing.

125. Make out a stock list for the above box, and estimate the cost of material.

126. If A receives 8¢ an hour, and B 6¢, the work done by B costs $\frac{1}{8}$ less than the work done by A. What change should be made in B's pay to equalize the cost of their work?

127. A cleated ceiling barn door 12' \times 12' is to be made. Allowing $\frac{1}{4}$ " waste, how much will the material, exclusive of cleats, cost @ \$40 per M?

128. If 18 laths cover 1 sq. yd., how many laths will it take to lath a room 18' \times 32' \times 9' 6" high, allowing for 6 windows 3' \times 7', and 3 doors 8' \times 3' 6"?

129. Make out a stock list for a $1\frac{1}{8}$ " doweled screen door, 2' 8" \times 6' 8", outside, stiles and top rails to be 4" wide, middle rail 5" wide, and bottom rail 7" wide.

130. Allowing $\frac{1}{4}$ waste, how many feet B. M. will there be in the above door?

131. An excavation is to be made for a cellar 20' square, and 6' deep. How many cubic yards of earth will have to be removed?

132. At $12\frac{1}{2}\phi$ per cubic yard, how much will the above excavation cost?

133. How many laths will it take to cover a house which has 6 rooms, averaging $12' \times 12' \times 8'$, making no allowance for openings?

134. If it costs \$1.75 to make and set an ordinary window frame, how much will it cost to make and set the frames in a given house?

135. The market price of window frames is \$1.50. Student A receives $12\frac{1}{2}\phi$ an hour, and makes a frame upon which the labor and material cost \$1.50, allowing 6' for waste at 3ϕ per foot. Student B receives 10ϕ per hour, and makes a frame which costs \$1.40, but wastes 11'. Which is the more profitable man?

136. Estimating lumber @ 4ϕ per foot, how much cheaper is A's labor than B's upon this job?

137. A plank is $2'' \times 12''$ and 18' long. How many feet B. M. does it contain?

138. A board which is 18'' wide when wet, shrinks, in drying, $\frac{1}{8}''$. How wide is it when it is dried?

139. A cellar $22' \times 35'$ is to be excavated 6' deep at one end and 4' at the other. How many cubic yards of earth will have to be removed?

140. A pitch roof house 40' long is to be built. The rafters are to be $2'' \times 6''$ 14' long, and placed 20'' to centers. Make stock list for the rafters.

141. At the rate of 60ϕ per square for labor, how much will the labor cost to lay a floor $65' \times 98'$?

142. A board weighs 42 lb. green; in drying, its weight decreases $\frac{1}{3}$. How much does it weigh when dried?

143. If 6 boxes cost \$3.50 to make, how much will 40 cost, if a price $\frac{1}{10}$ less is agreed upon on account of the larger number?

144. If the work would allow it, how many students, @ 8ϕ each per hour, would be needed to do the same work as 20 students, who receive 10ϕ each per hour?

145. How many times may a board 12'' wide be ripped, if the strips are to be 1'' wide, and the saw cut $\frac{1}{8}''$ wide? How wide a strip will be left?

146. If a board $14' \times 9''$ has a knot which destroys $\frac{1}{3}$ of it, how much good lumber is there left?

147. A receives 10ϕ per hour for his work, and B, 8ϕ . They are given a job together. How much of the work ought each to do?

148. How many square feet of flooring should be ordered to cover a floor 20' long, and 14' wide at one end, and 20' at the other, allowing $\frac{1}{4}$ waste?

149. A four-light window is $29'' \times 54''$ high; allowing 5'' in width and 6'' in height, what is the size of the glass?

150. If the above window weighs 24 lb., what size weight will be necessary? How many weights?

151. How many wooden tiles $5'' \times 5''$ will it take to lay a floor $15' \times 17' 6''$?

152. How many pounds of weights will be necessary to hang the windows of a given house properly?

153. How many feet of window cord will be needed to hang the above windows?

154. A partition 14' long and 8' high is to be put up. The material for the job costs \$40 per M, and the nails 20¢. The work is to be done by two students, receiving respectively 10¢ and 8¢ per hour, working 8 hr. each. Allowing $\frac{1}{4}$ waste, how much will the job cost?

155. How much will each student receive?

156. Nine pieces, each containing 1 sq. ft., are cut from a board containing 13'. How much of the board is wasted, if, by injudicious stock cutting, the rest of the board is worthless? No allowance is made for the saw cut.

157. A certain field is inclosed by a rail fence 4' 6'' high, $1\frac{1}{3}$ ft. of rails to the foot in length. The fence contains 1760' of fence rails. How long is the fence?

158. If the field is square, how many square feet are there in it?

159. If 18 laths are used to cover 1 sq. yd., how many 3d nails will it take to cover 786 sq. yd., using 7 lb. to 1000 laths?

160. If ten panels are each $17\frac{3}{4}''$ long, entering the groove $\frac{1}{2}''$, how long a piece of panelwork would they make if the rails were 3'' wide?

161. If sixteen $\frac{1}{4}''$ boards, each containing 9 sq. ft., are used upon a certain job, how many feet B. M. will be used?

162. A board is 14' long and 6'' wide; how many square feet are there in it?

163. How many feet of lumber 1'' thick will be used in laying a rough floor in a carriage house, which is $28' \times 24'$, allowing $\frac{1}{4}$ waste?

164. A floor is to be laid in a horse stable $20' \times 75'$ and 4'' thick. Allowing $\frac{1}{4}$ waste, how many feet B. M. will be used?

165. If the top rail of a door is 5" wide, with a $\frac{1}{2}$ " groove upon one edge, and a $3\frac{1}{2}$ " tenon is to be cut, leaving the rest for a relish, how wide will the relish be?

166. A halved and rabbeted joint is to be made of material which is 3" wide. If the rebate is $\frac{3}{8}$ " deep, how wide will the space between the rebates on the back be?

167. In making a table, the $\frac{7}{8}$ " rail is to be set back from the face of the leg $\frac{3}{8}$ ", and the tenon is to be $\frac{3}{8}$ " thick and in the center of the rail. How far from the face of the leg should the outside edge of the mortise be placed?

168. In making a stretcher joint of $\frac{7}{8}$ " material, the two back members will each be $\frac{1}{4}$ ". How thick will the face member be?

169. A and B receive jobs of the same character. A cuts up \$2 worth of material; B, \$2.40. A receives 10¢ per hour, and B, 9¢. A's time amounts to \$2; B's, to \$1.80. B thinks his pay should be raised to 10¢ per hour. Should it? Why?

170. A board fence 1250' long is to be built around an athletic field. It is 8' high and the boards cost 2¢ per foot. How much will the lumber, exclusive of the rails, cost?

171. Twelve boxes cost 72¢ each. How much will 30 boxes cost, if their price is reduced $\frac{1}{5}$ on account of the larger quantity?

172. A room 12' \times 15' and 8' high is to be ceiled. Allowing $\frac{1}{4}$ waste, and no openings, how much ceiling will it need?

173. If there are 18 rooms, averaging the same area as the above room, and the contract is given to furnish the labor of putting the ceiling on the walls for \$2.50 per M, what will the entire job cost?

174. If it takes 3 lb. of nails per M to lay the ceiling, how many nails will it take for the entire eighteen rooms?

175. The bottom rail of a door is 9", with a $\frac{1}{2}$ " groove in one edge and a $1\frac{1}{4}$ " relish on the other, and has two tenons, each $2\frac{3}{8}$ ", with a gain between them. How wide is the gain?

176. How many laths will it take to cover 549 sq. yd., allowing 60 sq. ft. for openings?

177. Allowing $4\frac{1}{2}$ " in width, and casings $1\frac{1}{2}$ " wide, how wide will the frame be, from outside to outside, for a 14" \times 28" four-light window?

NOTE.—It is the usual custom to allow 5" in width and 6" in height for a four-light window.

178. A board is 10' long and $12\frac{3}{4}$ " wide. How many feet B. M. has it?

179. B does $\frac{1}{3}$ less work than A, and receives 10¢ per hour. How much ought A to receive?

180. Although A does no better work than B, he is more careful in stock cutting and wastes $\frac{1}{10}$ less lumber. Should not B expect his pay cut down until he can cut stock more economically?

181. A timber $9'' \times 13''$ and 21' long contains how many feet B. M.?

182. In repairing furniture, A and B work together; A is careful, but B destroys a hand screw worth 25¢. A receives 10¢ per hour, and B, 8¢, though neither does more work than the other. How long will B have to work before the difference in his pay equals the price of the hand screw?

183. What should be the distance between the sill and the head stud of a $14'' \times 28''$ four-light window? Allow 6" beyond the glass for the height of the sash, 2" for the thickness of the sill of the window frame, and $2\frac{1}{4}''$ between the top of the upper sash and the head stud.

184. How many square feet in the wall and ceiling of a room $12' \times 16' \times 8'$ high, making no allowance for openings?

185. If the above room has a light area equal to $\frac{1}{4}$ of its wall surface, and glass $14''$ wide is used, what size of four-light windows should be ordered, and how many, allowing full size of glass for light area exclusive of the woodwork of the sash? Give total light area in square inches, and the number and size of windows of nearest stock size.

186. How many cubic yards of earth will be removed from an excavation $40' \times 60'$, and 3' deep at one end, and 5' deep at the other?

187. At $12\frac{1}{2}$ ¢ per cubic yard, how much must be paid for the work above described?

188. A plank is $2'' \times 14'' \times 18'$ long. How many feet B. M. are there in it?

189. A plank is $14' \times 9''$. How many feet B. M. are there in it?

190. If poplar is worth \$40 per M, how much is 963' worth?

191. Five workmen contract to build a barn; they use 6000' of lumber @ \$20 per M, 12,000 shingles @ \$1.75, and hardware, etc., at a cost of \$15. They each work 60 hr. The contract price was \$180. How much does each receive for his labor per hour?

192. How much would they have received if the lumber had cost only \$15 per M?

193. How many feet B.M. are there in a timber $9' \times 12'$ and $16'$ long?

194. Twenty-four tables cost \$1.50 each ; an order was to be placed for a second lot, if they could be figured down to $\frac{1}{10}$ less. The estimate was for $\frac{1}{15}$ less. What was the estimated price of the second lot?

195. Nine window frames were made at a profit of $\frac{1}{5}$, and each cost \$1.30. What was the entire cost of the job, including the profit?

196. If a window frame costs \$1.50, what will be the cost of the window frames in a house with 19 window openings?

197. Students A and B begin a job to get out a lot of small pieces. A picks up all the small pieces he can find around the shop, but B goes to the lumber shed and takes good whole boards. They both receive 8 ¢ per hour. The next month one of them has his pay increased $\frac{1}{4}$. Which one is it, and what is his new pay?

198. A $14'$ lumber pile had $2632'$ in it. It was built up of layers, averaging $4'$ wide. How many layers had it?

199. How many and what size of window weights will be required to hang 24 windows, each weighing, complete, 24 lb.?

200. What will be the cost of 42 drawing boards $2' \times 2' 6''$, allowing $\frac{1}{4}$ waste @ 4 ¢ per foot, and 5 hours' labor on each @ 8 ¢ per hour?

201. If A and B do a piece of work which cost \$3.20 for the labor, and C and D do the same work in 18 hr., at 10 ¢ and 8 ¢ per hour, respectively, which piece of work cost the more, and how much?

202. A does a piece of work which costs \$6.40 for the labor. If he works 10 da. of 8 hr. each, how much does he receive per hour?

203. If a man receives 80 ¢ for doing a certain job, and does it in 6 hr., how much will he make an hour?

204. If he does the work in an unsatisfactory manner, and to correct it, works 3 hr. more how much is his pay per hour for the job?

205. If it takes a boy 12 hr. to make a table, and he receives \$1.20 for labor, how much will he earn per hour?

206. What is the cost of the labor upon a house, if the material cost \$896, excavation and cellar, \$84, and painting, \$40?

207. A man has two lots of land which cost \$1000 each. He builds a house on one, and sells the house and lot for just enough to give him the other lot clear. The profit was $\frac{1}{10}$ of the cost of the house. For how much did he sell the property?

208. If the bottom of a tank is $5' \times 4'$, how high will the tank have to be to hold 520 gal. of water, estimating $7\frac{1}{2}$ gal. of water to a cubic foot, and allowing the sides to extend $2''$ above the height necessary to contain the water?

209. How many cubic feet are there in the above tank?

210. If another tank were to be made of the same height, to hold $\frac{4}{5}$ more water, how large would it be on the bottom, if it were perfectly square?

211. Three students take a job for \$3.90, with the understanding that A shall receive $\frac{1}{2}$, B, $\frac{1}{3}$, and C, the balance of the amount. How much does each receive?

212. A piece of property cost \$1200. It is rented for $\frac{1}{15}$ of its cost per year. What rent is paid per month?

213. This property is improved at an expense of \$300, and $\frac{1}{10}$ of this amount is added to the tenant's annual rentals. What is his rent per month?

214. If a student does $\frac{2}{15}$ of a job in 8 hr., how long will it take him to complete it?

215. A student is hired for 10 ¢ per hour, but for carelessness in stock cutting, his pay is cut down $\frac{1}{5}$. How much is he then paid?

216. If $\frac{1}{8}$ of 1000 ft. of lumber cost \$3.20, how much will 1000 ft. cost?

217. A builds a bookcase in 10 hr., but B needs 12 hr. to do the same job. If A receives 10 ¢ per hour, how much ought B to receive?

218. If $\frac{3}{4}$ of A's pay equal $\frac{1}{2}$ of B's, and C receives $\frac{1}{2}$ as much as both, or 10 ¢ per hour, how much do A and B receive?

219. How many feet B. M. should be purchased to board in a flat-roofed barn, $20' \times 30' \times 14'$ high, allowing nothing for waste or for openings?

220. A man bought 2000' of lumber @ \$40 per M, and upon resurveying it, found only 1968'. What was his money loss?

221. A man did $\frac{1}{3}$ of a piece of work one day, $\frac{2}{5}$ the next day, and $\frac{1}{15}$ the day following. How much of the work will have to be done at some other time?

222. How many feet B. M. are there in a board which is $14'$ long \times $8'$ wide?

223. If a student saves \$40 during the summer vacation, and spends $\frac{1}{2}$ of it for school fees and board, $\frac{1}{8}$ for clothes, and helps his

sister with $\frac{1}{3}$ of it, how much must he earn to pay his way the first term, if his expenses are \$27?

224. A and B take a contract to make 20 bookcases for \$20 each. If A does $\frac{2}{3}$ of the work, how much should each receive?

225. A, B, C, and D take a job together. A does $\frac{1}{4}$ of it, B, $\frac{5}{24}$, C, $\frac{3}{24}$, and D, $\frac{5}{12}$. What should each receive?

226. If B receives 7 ¢ per hour, and it takes him twice as long to do a certain piece of work as it takes A, who is paid $12\frac{1}{2}$ ¢ per hour, how much cheaper is 10 hr. of A's time?

227. If a table costs \$1.62 to make, what will be the price of 22 tables, if the price is reduced $\frac{1}{10}$?

228. Estimate the value of a given pile of dimension lumber.

229. If 12 panels are side by side with a 2" muntin between them and a 3" stile on each end, and if each panel is 9" wide, and enters the groove $\frac{1}{2}$ " upon each side, how long will the entire panelwork be?

230. Students A and B receive 8 ¢ per hour, respectively, and are given a job together. A does $\frac{2}{3}$ of the work. To what should A's pay be raised to make the cost of their work equal?

231. A student has been receiving 10 ¢ per hour, but as he spends time in nonsense, his pay is reduced $\frac{1}{5}$. What does he receive then?

232. How many 8ths of a foot are there in $7\frac{1}{2}$ "?

233. How many 12ths of a foot are there in $3\frac{3}{4}$ '?

234. What part of 9' is 4"?

235. What part of 10" is $\frac{5}{16}$ "?

236. What part of 9" is $3\frac{1}{2}$ "?

237. The aggregate of a column of mixed numbers is $94' 8''$, $\frac{27}{8}$ ". What is the total when reduced to feet and inches?

238. A student's term dues are \$27. He receives \$15 from home, and earns \$15 more. At the end of the term he is \$3.20 in debt. How much more than the necessary expenses has he spent?

239. A man does $\frac{1}{3}$ of a piece of work in $5\frac{1}{2}$ hr. How long will it take him to complete the entire job?

240. A receives $12\frac{1}{2}$ ¢, and B, 9 ¢ per hour. Upon a certain job they work together, and A does $\frac{2}{3}$ of the work. How much is B overpaid?

241. A student enters a boarding school with \$35 to pay his first term's dues, which is \$5 more than he needs. He wastes his money, and at the beginning of the third month he is short \$3 for his month's dues. Allowing \$6 for his last payment, how much has he wasted?

242. A lumber dealer bought 20,000 ft. of lumber @ \$20 per M. After culling and spending \$2 per M for handling it, he sold it @ \$26 per M. What part of the amount was profit?

243. From a pile of lumber containing 2240' B. M., a lumber dealer sold $\frac{1}{3}$ @ \$22.25 per M, $\frac{1}{4}$ @ \$25.80 per M, and the balance @ \$16.12 $\frac{1}{2}$ per M. How much did he receive for the whole pile?

244. A contract of \$80,000 is to be let in five sections of $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{12}$, $\frac{1}{16}$. How much is each subcontract worth?

245. Three tables of the following dimensions are to be made: tops 3' \times 4' \times $\frac{7}{8}$ " thick; legs 2" \times 3"; rails, 1" \times 5", mitered at the corners. The top is to project 2" over the rails on all sides. Make the stock lists for the three tables.

246. How many feet B. M. are there in the above tables? (Allow $\frac{1}{4}$ waste, and work to the nearest foot in estimating.)

247. Students A, B, and C make the tables. A makes his in 10 hr., and cuts 21' of stock; B makes his in 12 hr., and cuts 25' of stock; and C makes his in 15 hr., and cuts 30' of stock. Working upon a basis of 10¢ per hour for A, how much should the others be paid for their labor?

248. Considering that stock costs 4¢ per foot, how much more do the tables built by B and C cost than that built by A?

249. If the tables are sold for \$2 each, how much is made or lost upon each table?

250. A fence post is 9' long, and $\frac{5}{8}$ of its length is below ground. How much is in sight?

251. What will 6 $\frac{1}{2}$ cwt. of nails cost @ 3 $\frac{7}{8}$ ¢ per pound?

252. A man paid \$1450 for $\frac{5}{9}$ of a piece of property. How much was the property worth?

253. The property was sold for \$2800. What was his profit?

254. What will six 1" boards 16' long \times 7" wide be worth @ \$27.50 per M?

255. Two students do a certain piece of work for \$35, one furnishing $\frac{4}{9}$ of the time, and the other the balance or 7 hr. How much per hour does each receive?

256. A and B undertake a piece of work; A works $\frac{2}{3}$ of the time, and does $\frac{1}{2}$ of it; and B works the rest of the time, and finishes the job. How much ought A to receive, if B receives 8¢ per hour?

257. How much will 16 $\frac{3}{4}$ gross of screws cost @ 15 $\frac{1}{4}$ ¢ per gross?

258. If a student can do $\frac{4}{5}$ of a piece of work in 2 hr., how long will it take him to do the whole job?

259. If a student does $\frac{7}{11}$ of a piece of work in 4 hr., how long will it take him to finish the entire work?

260. Make out the stock list for a box 2' 5" long, 1' 3 $\frac{1}{2}$ " wide, and 7 $\frac{1}{2}$ " deep. All dimensions are inside, and the box is made of $\frac{7}{8}$ " stock.

261. Estimate the exact number of square feet of lumber used in making the above box.

262. If $\frac{4}{5}$ of a keg of nails cost \$1.60, how much will the entire keg cost? Weight of keg is 100 lb.

263. A student pays \$18 for his entrance fees, which is $\frac{5}{9}$ of all the money that he has. How much has he?

264. A board is 14' long, and contains 9 $\frac{1}{2}$ sq. ft. How wide is it?

265. A student spends \$100 for a year's work at school. He earns $\frac{6}{17}$ of it, and pays the balance from money he brought with him. How much was left, if he brought \$75 with him?

266. A certain job cost \$1.46, of which $\frac{2}{3}$ was for stock, $\frac{1}{10}$ for profit, and the balance for labor @ 8¢ per hour. How much labor was furnished?

267. Measure with a tape a given lot of land, and estimate the number of square feet in its area.

268. Estimate the amount of lumber in a given lumber pile.

NOTE. — This is done by approximation; estimate the amount of an average layer, and multiply it by the number of layers or courses.

269. A job cost \$3.15; $\frac{2}{3}$ of the cost was for material, and $\frac{1}{2}$ of the price of the material equaled the cost of the labor. What did the labor cost?

270. Measure a certain piece of furniture for a packing box, allowing $\frac{3}{8}$ " all around for packing. Make the stock list and estimate the cost.

271. A man paid \$35 for repainting a house, which was $\frac{1}{27}$ of the amount he paid for the property. What was it worth?

272. After painting the house, he sold the property for \$1025. How much did he make?

273. A student was given 5 lb. of nails for a certain job, but used only 3 $\frac{3}{4}$ lb. At \$4 per hundredweight, what was the value of those returned?

274. D receives $\frac{1}{4}$ more pay than A. B receives $\frac{1}{2}$ as much as A and B together. D receives $12\frac{1}{2}\phi$ per hour, which is $\frac{1}{2}$ of the total which the others receive. How much do A, B, and C each receive?

275. A lot of land is worth \$250. The barn is worth \$527, and the value of the house equals the value of the barn plus $7\frac{2}{3}$ times that of the lot. What is the value of the entire property?

276. From the ground, or grade line, to the sills of a house, it is $24\frac{5}{8}''$; from there to the lower window sills, it is $30\frac{1}{4}''$; to the window header, it is $5' 2\frac{7}{8}''$; to the frieze, it is $3' 4\frac{5}{8}''$; to the edge of the eaves, it is $12\frac{3}{16}''$. What is the entire height of the eaves from the ground?

277. A certain piece of work requires 79 hr. of labor. A works .4 of it; B, .3; C, .15, and D finishes it. How much time does D work?

278. A receives \$.10 per hour; B, .7 as much; C, $\frac{3}{4}$ as much, and D, $\frac{2}{3}$ as much. How much does each receive per hour?

279. If B is worth $\frac{3}{4}$ as much for 6 hours' work as A is for 8 hours' work, how much would he receive for $7\frac{1}{2}$ hours' work?

280. If D is worth $\frac{3}{4}$ as much as B in the above problem, how long would he have to work to earn the same amount as B?

281. If E, being a journeyman, can do $\frac{1}{2}$ as much continuously as can A, B, C, and D, in problem 278, how much ought he to receive per hour?

282. If A can do a piece of work in 12 da. and B in 10 da., how many days ought they to take if they do it together?

283. If A and B can build a barn in 8 da., and A could do it alone in 12 da. how long would it take B to do it without help?

284. A and B contract to build a cornerib. It takes them 10 da., A doing $\frac{2}{3}$ as much as B. What part does each do in a day?

285. If they are to receive \$20 for the labor upon the job, what should be the share of each?

286. If a student makes a bookcase in $6\frac{1}{2}$ hr., how long will it take him to make 12 of them, if he saves $\frac{1}{8}$ of his time by making a number?

287. At $2\frac{1}{8}\phi$ per pound for nails, how many will \$20 $\frac{3}{8}$ buy? Answer in decimals.

288. How many feet B. M. are there in a board which is 16' long and 9" wide?

289. How many feet B. M. are there in a pile of $2'' \times 6''$, 14' long, containing 140 pieces?

290. How many feet B. M. should be purchased to lay a matched floor $20' \times 35'$, allowing $\frac{1}{4}$ waste?

291. Allowing 2 lb. of nails to the square, how many nails will be necessary to lay the above floor?

292. Paying 60¢ per square for labor, how much will it cost to lay the above floor?

293. Make out the stock list for a piece of panelwork which contains 4 panels, the outside dimensions of which are 4' long, 18" high. All rails, stiles, and muntins are to be 3" wide, and the panels are to fit into grooves $\frac{1}{2}"$ all around.

294. How many days' work will there be in laying 75,650 shingles, at the rate of 2000 per day?

295. If two men can lay 800' of flooring in a day, how many men will be required to lay 40,000' in 5 da.?

296. At \$.75 per M for laying, how much will the labor cost upon a shingle roof 40' long, with rafters 14' long?

297. The cost of the material for a certain piece of work is $\frac{2}{3}$ of its entire cost. \$2.50 was paid for the labor. What was the price of the finished work?

298. A plank is $2'' \times 16''$ and 24' long. How many feet B. M. are there in it?

299. A timber is $10'' \times 16''$ and 32' long. How many feet B. M. are there in it?

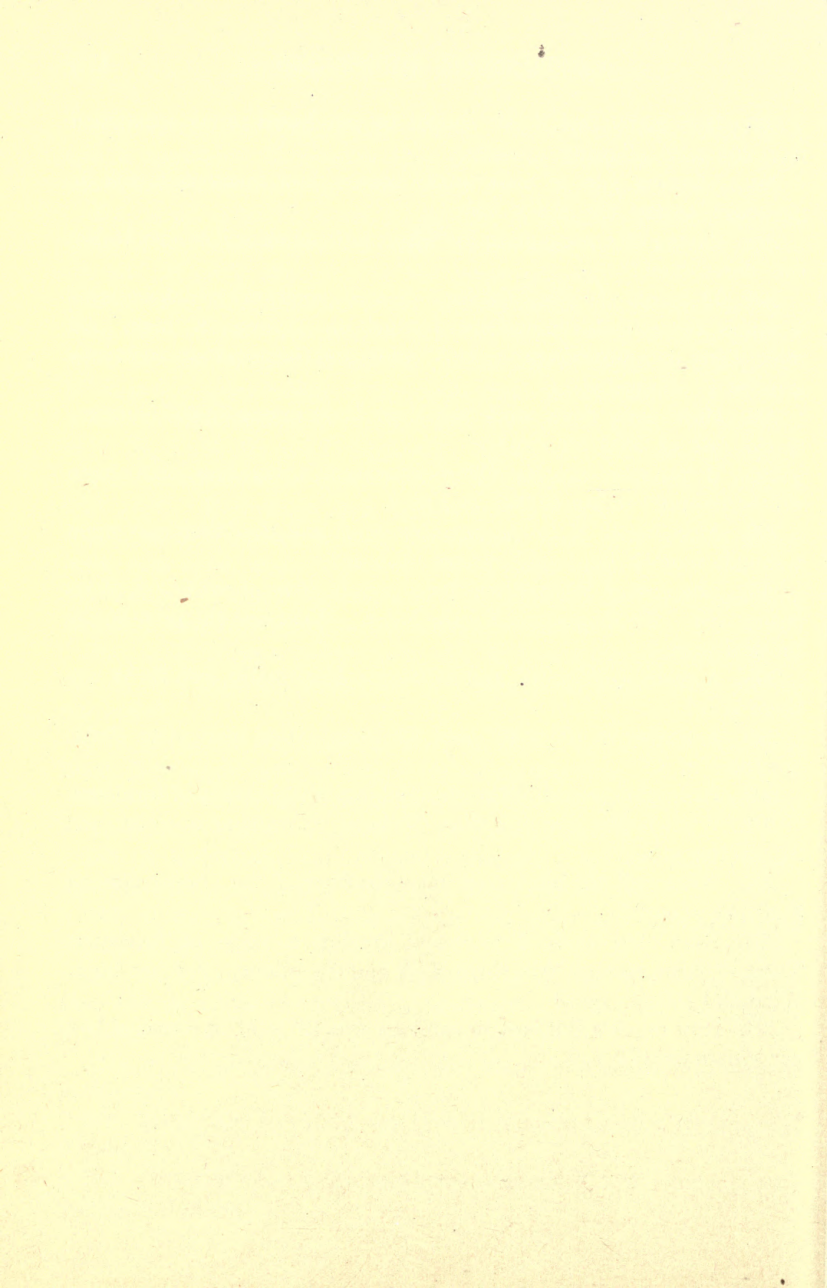
300. Estimate the cost of the material in a certain piece of furniture.

301. What is the area of a floor 40' long, 16' wide at one end, and 24' at the other?

302. What will the labor cost upon the floor of the above room @ \$.60 per square?

303. Nine men work 2 hr. each, moving a piece of furniture. Three of them receive $8\frac{1}{2}\%$; three, $7\frac{1}{2}\%$, and the others, $12\frac{1}{2}\%$ per hour. What did the job cost?

304. How much will it cost to paint an area $12' \times 36'$ at a cost of 10¢ per square yard?



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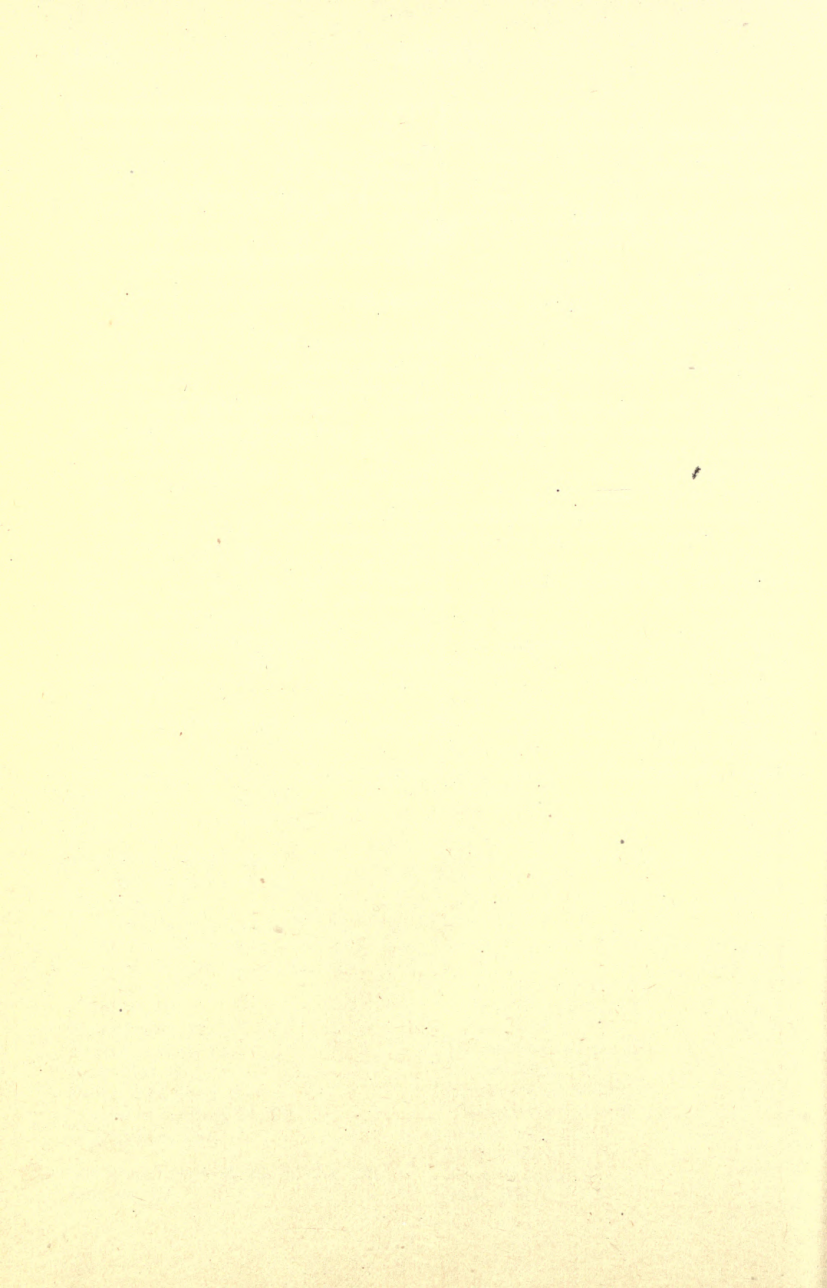
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